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REMARKS

UPON THE

Newtonian Philoſophy,

As propos'd by

Sir ISAAC NEWTON, in his *Principia Philoſophiæ Naturalis*; and by Dr. GREGORY, in his *Principia Aſtronomiæ Phyſicæ*.

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WHEREIN

The Fallacies of the pretended Mathematical Demonſtrations, by which thoſe Authors ſupport that Philoſophy, are clearly laid open; and the Philoſophy it ſelf fully proved to be falſe and abſurd, both by Mathematical and Phyſical Demonſtration.

By *GEORGE GORDON.*

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Remarks, &c.

THERE is nothing to which the Philoſophers of all Ages have ſo generally applied themſelves, as to the Study of Nature; and there is no Study in which they have been able to make ſo little Progreſs as in this, eſpecially in that Part of it which is employ'd in diſcovering the Cauſes of the beautiful Order and ſteddy Motions of the Sun, Moon and Stars: And if we conſider their Schemes of this Part of Natural Philoſophy, we ſhall find them All built either upon groſs Abſurdities, or Words without

Meaning; and evidently ſee that Human Underſtanding, even in its greateſt Perfection, is very unequal to ſo hard a Task as the ſearching out this myſterious Cauſe.

Our Philoſophers have now got into a Way of treating that Part of Natural Philoſophy in the ſame Method with Mathematicks; and by this Management, propoſe to make it more certain than formerly, and to get Mathematical Demonſtration to determine this Point, which has deceived ſo many of their Predeceſſors. It is moſt certain that Mathematicks give very great Aſſiſtance to Natural Philoſophy; but I cannot ſee the Advantage of handling Natural Philoſophy it ſelf, in the ſame Method as Mathematicks; and am inclined to believe that our Modern Philoſophers have made uſe of the Mathematical Way, rather becauſe the Study of Mathematicks (to which they were moſt accuſtomed) had made that Method moſt eaſy and familiar to them, than for any real Advantage there is in handling Natural Philoſophy in ſuch a Manner. For though it be true that the Thing which is moſt wanted in Natural Philoſophy, is to make its Propoſitions more certain, and that the Proofs of Mathematicks are of all others the moſt certain, yet this Certainty in the Proofs of Mathematical Propoſitions, ariſes from the Nature of the Subject of that Science, and not from its Method. For it is becauſe we have clearer Ideas of the Relations of Quantities, the Subject of Mathematicks, than of the poſitive Properties of real Beings, the Subject of Natural Philoſophy, that the Propoſitions of the former Science can be proved more clearly than thoſe of the latter; and not becauſe in the one Science we have a better Method of propoſing our Reaſons, than in the other. It's true, the Method of proving Mathematical Propoſitions, is the fitteſt for ſhowing ſuch an evident Chain of Connexion as thoſe

Propoſitions have with the cleareſt Principles, becauſe there is no more to be done, but in a plain eaſy Manner to expreſs this Connexion, which when barely propos'd, ſhines by its own Light. But there is ſo little Evidence in many of the Principles upon which Natural Philoſophy depends, and the Chain of Connexion is ſo dark, that methinks no Man ſhould attempt to ſhow it in the ſame eaſy and peremptory Method with Mathematical Demonſtrations; and in my Opinion, the Mathematical Method, inſtead of being an Advantage to Natural Philoſophy, is as unfit for it, as for the Diſputes of the Barr, or thoſe of the Cabinet Councils of Princes.

But whatever Advantage or Diſadvantage there be in this Method of handling Natural Philoſophy, and of proving its Propoſitions, yet theſe Proofs can never be Mathematical Demonſtrations; nor can they be made better by any Method, than their own Nature, and the Nature of their Subject will allow. So that notwithſtanding our Modern Natural Philoſophy is propoſed to the World in a Mathematical Dreſs, it is Natural Philoſophy ſtill, and not Mathematicks. It is that ſame Science which has ſo often deceived the greateſt Philoſophers, in which the greateſt of Men have been often convicted, and are ſtill to be ſuſpected of Errors; and not that Science, in which any Man of common Senſe is capable to force the Aſſent of the moſt ſtubborn and ſubtil Diſputant. So that I ſee no Reaſon why the Dreſs of this Philoſophy ſhould cauſe Men to ſtand ſo much in Awe to examine its Sufficiencies as they do.

The Account we have of the new found Cauſe, which, according to this new Philoſophy, keeps the whole Syſtem of the Univerſe in Order, makes that Philoſophy to me ſeem much to be ſuſpected. The famous Sir *Iſaac Newton*, its Author, tells us, * That it is a Virtue or Power which Bodies have to attract or draw one another; that every Particle of Matter has this Power or Virtue; that it reaches to all Places at all Diſtances, and penetrates to the Center of the Sun and Planets; that it acts not upon the Surfaces of Bodies as other Natural Agents, but upon their whole Subſtance or ſolid Content, *&c.* and if ſo, what a ſtrange Thing muſt it be.

I confeſs that the many Inſtances of unintelligible Cauſes that have been aſſigned by the greateſt Philoſophers for the Production of thoſe ſurprizing Phænomena of the Motions of the Heavens, make me ſuſpect this Cauſe, which looks as monſtrous as any of the Fictions of Antiquity; and the Mathematical Dreſs of the Arguments which ſupport that Cauſe, does not hinder me from ſuſpecting their Sufficiency: And I perſwade my ſelf, that my *Remarks*

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* *Page* ult. *Prin. Math. and elſewhere.*

marks upon thoſe Arguments will neither be uſeleſs nor diſagreeable to the Learned World.

The Chief Perſons who have propos'd to the World this Scheme of Phyſicks, and the Reaſons that ſupport it are, Sir *Iſaac Newton*, in his *Principia Philoſophiæ*, and Dr. *Gregory*, in his *Principia Aſtronomiæ Phiſicæ*, &c. and to avoid Confuſion, I ſhall take theſe Reaſons from thoſe Authors only.

Mr. *Newton*, L. 3. Prop. 1. aſſerts of the *Satellites* of *Jupiter* and *Saturn*, that they are hindred from moving in ſtreight Lines, (which Bodies naturally affect) and kept in their Orbits, by a Force directed to *Jupiter* and *Saturn*. Prop. 2. He aſſerts of all the Primary Planets, that they are hindred from running out in ſtreight Lines, and kept in their Orbits, by a Force directed to the Sun. And Prop. 3. He aſſerts of the Moon, that ſhe is kept in her Orbit by a Force directed to the

Earth; and for Proof of theſe Three Aſſertions, refers to his Account of the *Phænomena* of the Motions of thoſe Bodies, and to his 2d and 3d Prop. of his 1ſt Book.

The *Phænomena* to which he refers are, that the *Satellites* of *Jupiter* and *Saturn* appear to move ſo, round *Jupiter* and *Saturn*, the Primary Planets round the Sun, and the Moon round the Earth, as to deſcribe round them Areas proportionable to the Times; by which he means that the Areas comprehended within any Parts of the Curve which thoſe Bodies deſcribe, and Lines drawn from both Ends of thoſe Parts to that Body round which they move, are as the Times in which the Body did deſcribe thoſe Parts of the Curve.

It may be very true that the *Satellites* of *Jupiter* and *Saturn* deſcribe round *Jupiter* and *Saturn*, the Primary Planets round the Sun, and the Moon round the Earth, Areas proportionable to the Times; but this neither does nor can appear to any great Exactneſs from Obſervation, at leaſt if order'd by Rules independent of Mr. *Newton*'s Philoſophy; and to infer from Rules depending upon that Philoſophy, that the Planets deſcribe ſuch Curves, and from their deſcribing ſuch Curves again to prove that Philoſophy, is not fair Reaſoning. Nay, according to Mr. *Newton* himſelf, it cannot appear that theſe Bodies deſcribe ſuch Curves, becauſe by the Proſecution of his Subject, he is forced * afterwards to affirm of all the Planets, particularly of *Jupiter*, *Saturn*, and the Earth, that they do not move in that Manner. Notwithſtanding, I ſhall not inſiſt upon this; but ſuppoſe that the Planets appear to move as Mr. *Newton* ſays.

In the 2d and 3d Prop. of his 1ſt Book, he aſſerts, that all Bodies moving in any Curve, which in a Plan deſcribes round any other Body dy (whether in Motion or at Reſt,) Areas proportionable to the Times, are forced into ſuch a Curve by a Force directed to that Body, round which they deſcribe thoſe Areas. Dr. *Gregory*, in aſſerting the ſame Thing, propoſes the Caſe of the Body round which the other revolves being in Motion, and the Caſe of its being at Reſt, ſeperately, and ſo ſets this Matter in a clearer Light; whoſe Method I ſhall follow, and take firſt the Caſe of that Body being at Reſt, as he does.

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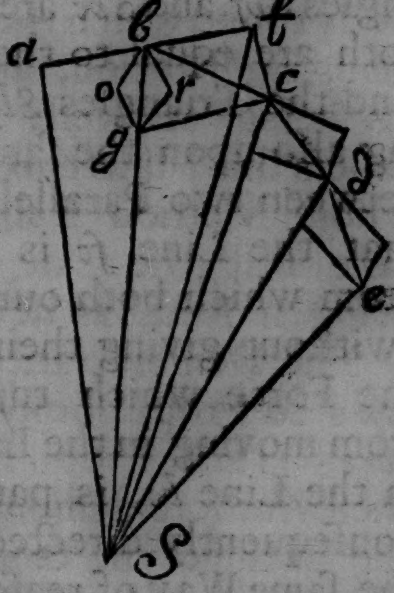
* *Prop.* 13. *L.* 3. Prin.

The Demonſtration of Mr. *Newton*'s 2d Prop. Book 1. and Dr. *Gregory*'s 12th Prop. Book 1. where theſe Authors demonſtrate this Caſe, are in Effect the ſame; but Dr. *Gregory* proves it more fully, and I ſhall repeat the Demonſtration of this, ſo as to comprehend what they both ſay: For it is needleſs ſeperately to repeat their Demonſtrations, where they differ in nothing, but that the one is more full and clear than the other. And this Method of repeating

ing their Arguments, I ſhall obſerve all along. The Demonſtration of Mr. *Newton*'s 2d, and Dr. *Gregory*'s 12th Prop. is as follows:

Let the moving Body move in the Line *a b c d e*. Divide this Line into ſuch Parts *ab*, *bc*, *cd*, *de*, as the Body deſcribes in equal Times. Let the Body at Reſt be *S*, draw *bf*=*ab*, draw *aS*, *bS*, *fS*, *cS*, *dS*, *eS*. The Body in any certain Time deſcribing the Line *ab*, would if nothing hinder it, deſcribe in equal Time *bf*=*ab*, by the Nature of Bodies in Motion: And ſince it deſcribes not *bf* but *bc*, it is turned from moving in *bf* by ſome Force. Suppoſe by the centripetal Force *bg*. The Triangles *Sbf* and *Sab* are



are equal, becauſe their Baſes *ab* and *bf* are equal, and their Altitude is the ſame; the Triangles *Sbc* and *Sba* are equal, becauſe they are the Areas deſcribed in the equal Times *ab* and *bc*, and the Areas are *Ex Hypotheſi* as the Times; but the Triangles *Sbf* and *Sbc* are equal, becauſe both are equal to the Triangle *Sab*. And the Triangles *Sbf* and *Sbc*, being alſo upon the ſame Baſe, *Sb* are between two Parallels *Sb* and *fc*; ſo that the Line *fc* is parallel to *Sb*. From which both our Authors infer, (without giving their Reaſon) that the Force which turned the Body from moving in the Line *bf*, to move in the Line *bc*, is parallel to *cf*, and conſequently directed to *S*. And by the ſame Way of reaſoning, it's plain that the Force acting in all the other Points *c*, *d*, *e*, &c. may alſo be proved to be directed to *S*.

The Reaſon why our Authors conclude that the Force turning the Body from moving in the Line *bf*, to move in the Line *bc*, muſt be pa-

parallel to *cf*, is obvious upon drawing the Parallelogram *b f c g*: For both thoſe Authors take it for a known Truth in Mechanicks, that a Body by two Forces joyning, will deſcribe the Diagonal of a Parallelogram, in the ſame Time it would by any one of thoſe Forces deſcribe one of the Sides. And one of the Forces joyning to produce the Motion *bc*, being *bf*, the other muſt be the other ſide *bg*, parallel to its oppoſite Side *cf*.

It is obſervable, that all that can here be inferred is, that the actual Motion of the Body in the Line *bc*, may be reſolved into the Forces *bf* and *bg*; but then it may as well be reſolved into *bf*, *bo* and *br*; as appears by deſcribing the Parallelogram *b o g r*. So that the Forces *bo* and *br*, neither of which are directed to *S*, might have turned the Body from the Motion *bf* to the Motion *bc*, as well as the Force *bg*. And therefore this Demonſtration, inſtead of proving what is aſſerted, that all

Bodies endeavouring to move in the Line *bf*, and really moving in the Line *bc*, are turned from *bf* into *bc*, by a Force directed to *S*, only proves that it is poſſible for this Force to turn the Body from *bf* to *bc*, ſince this Force *bg* is really no more than one of an infinite Number of poſſible Forces that may turn the Body from *bf* to *bc*.

It is to no Purpoſe to anſwer, that *bo* and *br*, or any Forces which can turn the Body from *bf* to *bc*, are equivalent to *bg*; that, is when joyned together will produce like Effects with *bg*. It is plain indeed, that ſince the Effect of *bg* in Conjunction with *bf* is to produce *bc*; whatever in Conjunction with *bf* will alſo produce *bc*, is in that Reſpect equivalent to *bg*; but then this does not make appear that any of the Forces *bo* or *br* are themſelves directed to *S*, and can give no Satisfaction when the Nature of any real Force that produces any actual Motion is in Queſtion, eſpecially the actual Motions of Bodies of any conſiderable Bulk, which are always moved by ſeveral Forces joyning together: For Inſtance, a Ship carry'd in a Stream, and a Man walking on the Ground, may eaſily be ſuppoſed to deſcribe, round ſome Body or other, Areas proportionable to the Times, to as great Exactneſs as any Man from Obſervation can affirm that the Planets do. The Force that moves the Ship, is the Preſſure of the Particles of Water upon her Sides, in many Millions of Directions; and the Force that moves the Man's Body, is the Action of his Animal Spirits contracting his Muſcles in as many Directions. Now, what Idea can any Man have of the Nature of any of thoſe two very different Cauſes, from being told that the whole Forces by which thoſe Motions are perform'd, when joyned together, are equal to one directed to that Body, round which the Ship, or the Man's Body, deſcribe Areas proportionable to the

Times? And what little Reaſon have we from this, to conclude thoſe very different Cauſes to be alike? Or what a ridiculous Thing were it, from this to infer that the Ship, or Man, were attracted by ſome Virtue proceeding from thoſe Bodies, round which they deſcribed ſuch Curves, and that this Attraction were the Cauſe of their Motion? And yet, our Authors have no better Reaſon from this Propoſition, to conclude that the Stars are moved by the Attraction of that Body, which is in the Center, or in one of the Foci of their Orbits.

Notwithſtanding what I have ſaid, this Argument would ſtill prove that a Body moving in any Curve, that in a Plan deſcribes round a certain Point Areas proportionable to the Times, may be forced from a ſtreight Line into thoſe Curves, by a Force directed to that Point: Though it falls far ſhort of proving the poſitive Affirmation, that all Bo-

Bodies moving in any ſuch Curves, are forced into ſuch Motion by a Force of that Direction. The Difference betwixt theſe two Proofs is very conſiderable, for the latter is a Demonſtration, *a priori*, and yields an abſolute Certainty, that any Body deſcribing ſuch a Curve as the Propoſition expreſſes, muſt neceſſarily be actuated by the Cauſe which the Propoſition aſſigns; whereas the former is only a Demonſtration, *a poſteriori*, and ſhows no more than a Poſſibility, that the Cauſe aſſigned in the Propoſition may produce the Motion which the Propoſition expreſſes. Now to ſhew a Certainty that a Thing is ſo, and a Poſſibility that it may be ſo, are very different.

But after all, I have repreſented this Fault in this Demonſtration to be great, only becauſe it is ſo in Reſpect of what the Propoſition aſſerts; for this Defect is not in it ſelf ſo great as ſome may poſſibly imagine: For to ſpeak Truth, nothing

thing ſhould have been affirmed but this Poſſibility; for it's impoſſible to prove any more in ſuch Caſes. Nay, it is a great Matter in Phyſicks, to come this Length, to be abſolutely certain that the Cauſe we aſſign for an Effect, may poſſibly produce it, or is no Ways inconſiſtent with it; which is what we call accounting for an Effect from a Cauſe. And when an Effect may be accounted for from a Cauſe, if ſome conſiderable Inconvenience in ſuppoſing this Cauſe to produce that Effect do not appear, we reckon our ſelves certain that that Effect is produced by that Cauſe: Not that we are ſtrictly ſpeaking certain of it; but becauſe this is the greateſt Certainty we can for the moſt part reach in the abſtruſe Points of Natural Philoſophy. And if Mr. *Newton* had not, by the Habit of affirming Dogmatically in Mathematicks, ſlipt into a poſitive Affirmation, that all Bodies moving in ſuch Curves as he defines, are forced into thoſe Curves by the Force he condeſcends on, and had only ſaid that all ſuch Motions might be produced by this Cauſe; his Argument, notwithſtanding the Fault I have obſerved, if it had no other, would have been a valuable Argument in Natural Philoſophy, though not ſufficient for a Foundation to that mighty Superſtructure that is built on it.

But the Truth of the matter is this, our Authors Argument will not ſupport the Affirmation of a Poſſibility, that the given Cauſe can produce the given Effect; which is its great Fault; and if I can make that appear, this Argument will appear to be of no manner of uſe.

In order to make this appear, let us conſider that the Propoſition is affirmed of all Bodies moving in any ſort of Curves, that in a Plan deſcribe round a certain Point Areas proportionable to the Times. Now there are many very different Kinds or Species of ſuch Curves, to wit, Circles, Elipſis's, Hyperbolas,

las, Parabolas, Cicloyds, Spiral Lines; nay, any kind of Curve lying upon a Plan may be performed with ſuch a Motion, as to deſcribe round ſome certain Point Areas proportionable to the Times. So that this Propoſition is affirmed of all ſorts of Curves lying in a Plan, provided they be performed by a certain ſort of Motion.

It is neceſſary that this Propoſition ſhould have been conceived as it is in general Terms, to make it fit for the uſe that is made of it; which is to infer from it, that thoſe particular Curves which the Planets deſcribe, may or muſt be produced by a Centripetal Force. For to juſtify this Inference, it's plain that the Propoſition ought either to prove in general of all Kinds of ſuch Curves, that they may be produced by ſuch a Cauſe, or at leaſt to prove this of thoſe particular Kinds of ſuch Curves, which the Planets are ſuppoſed to deſcribe; and ſince in this Propoſition there is no particular Species of ſuch Curves mentioned, the Propoſition muſt neceſſarily be underſtood in the ſame Terms, in which it is very explicitly conceived, *viz.* to affirm in general of all Curves that in a Plan deſcribe round a certain Point Areas proportionable to the Times, that they are, or at leaſt may be, produced by a Force directed to that Point, turning the Body that deſcribes theſe Curves from ſtreight Lines; or if this Propoſition is not ſo underſtood, it will not ſerve to prove the 1ſt, 2d and 3d Prop. L. 3.

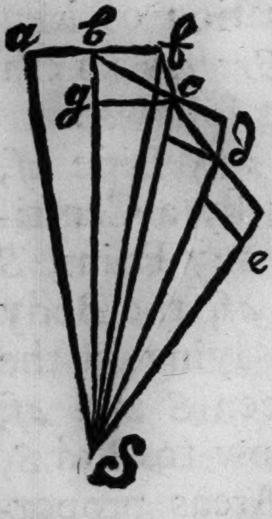
It appears very clearly from the Demonſtration of Mr. *Newton*'s 2d and Dr. *Gregory*'s 12th Prop. L. 1. or from thoſe Demonſtrations as I have faithfully repeated them, that a Centripetal Force is ſuppoſed to produce the Curve of which the Propoſition ſpeaks, *viz.* all Curves which in a Plan deſcribe round a Point Areas proportionable to the Times; and it is only demonſtrated that the Point round which the Curve deſcribes thoſe Areas, is the Center or Point to which this Force is directed; Whereas the main Thing to have been proved, was that a Centripetal Force could produce all or any Species of ſuch Curves; which is ſuppoſed and not proved. Till this be proved, we are uncertain whether it be poſſible for any Centripetal Force to produce all ſorts of Curves that in a Plan deſcribe round a Point Areas proportionable to the Times; or whether it be poſſible for a Centripetal Force to produce thoſe particular Kinds of ſuch Curves which the Planets deſcribe: Nay, for any thing we learn, from this Argument it may be demonſtrable that ſuch a Force can neither produce all ſuch Curves, nor thoſe particular Species of ſuch Curves which the Planets deſcribe; and ſince this Uncertainty is left, and the main Thing that ought to have been proved is ſuppoſed only, this whole Argument can be of no manner of uſe.

But to deal with all the Fairneſs imaginable in this Matter, it's true that both our Authors have a Proof which to ſome People may perhaps ſeem to be a Proof of this Point; and this Proof I ſhall faithfully repeat, and clearly ſhow that it proves not the Point in Queſtion. This Proof is the Demonſtration of Mr. *Newton*'s 1ſt and Dr. *Gregory*'s 11th Prop. L. 1. which is as follows:

If a Body move in any Line *af*, and be forced from it by a Centripetal Force directed to any Point, *S* not lying in the Line *af*, the Body will move in a Curve lying in the Plan that paſſes between *S* and *af*, the Curve will be hollow toward *S*, and deſcribe round it Areas proportionable to the Times. The Demonſtration is,

Suppoſe the Body in any certain Time to deſcribe the Line *ab*, it would by the Nature of Bodies in Motion deſcribe $bf=ab$ in an equal Time if nothing hinder it; and if it is acted upon by the Centripetal

Force *bg*, it will alſo in equal Time deſcribe the Diagonal of the Parallelogram *bfcg*, viz. the Line *bc*. The Triangles *Sab* and *Sbf* are equal, becauſe their Baſes *ab* and *bf* are equal, and their Altitude is the ſame. The Triangle *Sbc* and *Sbf* are equal, becauſe on the ſame Baſe *Sb*, and between the ſame Parallels *Sb* and *fc*; but *Sbc* is equal to *Sab*, becauſe both are equal to *Sbf*, and theſe are the Areas deſcribed in equal Times *ab* and *bc*. By the ſame Reaſoning the Force directed to *S*, acting again in the Point *c*, muſt force the Body to deſcribe the Area *Scd*, in the ſame Time it deſcribed the Areas *Sab* or *Sbc*; and ſo for any Number of ſuch Areas: And if any two Numbers of ſuch Areas be taken, the Sums of theſe Areas will be to one another as the Sums of their Times; or if theſe



theſe Areas be proportionably deminiſh'd, they will be to one another as before. Let us then ſuppoſe our Centripetal Force not to act at different Times upon the Body in diſtant Points of its Motion, but continually and in every Point of its Motion; and conſequently ſuppoſe the Lines *ab*, *bc*, *cd*, *de*, &c, and the Areas comprehended within theſe Lines, to be diminiſh'd in Infinitum, ſo as to bring the Points *b*, *c*, *d*, *e*, &c. in which the Force is ſuppoſed to act, next to one another; then will the Line *a b c d e* be a Curve, and the Areas this Curve will deſcribe round *S*, will be proportionable to the Times as above. It's plain that it will alſo lie in a Plan, and be hollow towards *S*, &c.

In this Demonſtration it's evident that nothing is proved, but that a Centripetal Force will turn a Body into a Curve, in a Plan deſcribing round this Center Areas proportionable to the Times: that is to ſay, will produce ſuch a Curve;

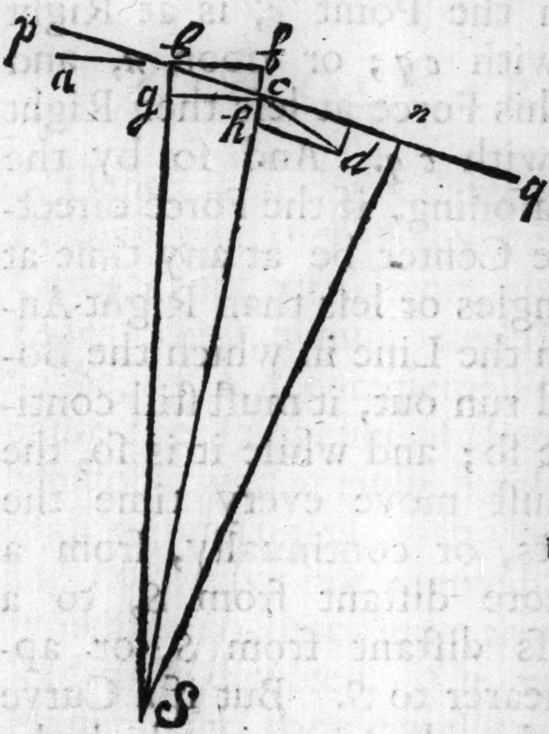
but it neither is aſſerted nor proved that it can produce all ſuch Curves; neither is there in this Propoſition any Species of ſuch Curves mention'd. So that it proves no more than that ſome ſort of Curves, which in a Plan deſcribe round a Point Areas proportionable to the Times, may be produced by a Centripetal Force turning a Body from a ſtreight Line, without ſhowing whether any more than one Species of ſuch Curves can thus be produced, or ſo much as what that one Species which may be ſo produced is. So that if that which is ſuppoſed in Mr. *Newton*'s 2d, and Dr. *Gregory*'s 12th Prop. L. 1. *viz.* That a Centripetal Force can produce all ſuch Curves, be deny'd, there is here no Proof of it; but the Matter is left at an abſolute Uncertainty, and we are ſo far from knowing that a Centripetal Force can produce all Curves, which in a Plan deſcribe round that Center Areas proportionable to the Times, that we know not whether this Cauſe can produce any more then one Species of ſuch Curves: nay, not ſo much as what this one which it can produce is. And ſince this Matter is left at ſuch an Uncertainty, I ſhall proſecute the Demonſtration of Mr. *Newton's* 1ſt and Dr. *Gregory's* 11th Prop. L. 1. and demonſtrate in the following *Theorem*, what that Curve is which this Cauſe can only produce.

THEOREM I.

A Body turned from a ſtreight-lined Motion into a Curve that lies in a Plan, and deſcribes round any Point S, *Areas proportionable to the Times, by a continuing Centripetal Force directed to* S, *muſt either move conſtantly away from* S, *or come conſtantly nearer to it in a Spiral Line.*

Let the Body's ſtreight-lined Motion be the Line *a b f*, let the Centripetal Force directed to *S*, be ſuppoſed to act upon the Body at the

Point *b*, the Line *bf* in which the Body at *b* would run out, muſt make with *bS*, the Line of the Direction of the Centripetal Force acting in *b*, either a Right, an Acute, or an Obtuſe Angle. If the Angle *Sbf* be a Right or Acute Angle, then is the Angle *Sbc* (a Part of that Angle) leſs than a Right Angle. Draw out *bc* in Infinitum toward *q* and *p*, let us with our Authors conceive the Point *c* to be the next Point in which the Centripetal Force acts; which being ſuppoſed to act continually or in every Point, the Point *c* muſt be the next Point to *b* in the Line *bq*. Drop a Perpendicular from *S*, upon the Line *pq*, it will fall ſomewhere betwixt *b* and *q*; either upon *c* the next Point to *b* in that Line, or upon ſome other Point betwixt *c* and *q*: Suppoſe upon the Point *n*. If the Perpendicular fall upon *c*, then is *c* the neareſt Point in the Line *pq* to the Point *S*, nearer to wit than the Point *b*; if the Perpendicular fall upon *n*, then is *c* nearer to *S* than *b*, be-



becauſe nearer to *n*: So that the Centripetal Force meeting with the Line in which the Body would run out at Right Angles, or leſs than Right Angles, muſt neceſſarily force the Body to move from a Point more diſtant to a Point leſs diſtant from the Center *S*. The Line *c q* is that Line in which the Body at *c* would run out next, and the Point *c* is the next Point in which the Centripetal Force is ſuppoſed to act; but a Perpendicular from *S* upon *p q* fell, as above, either upon *c*; and then the Force directed to *S* acting in the Point *c*, is at Right Angles with *c q*; or upon *n*, and then is this Force at leſs then Right Angles with *c q*. And ſo by the ſame Reaſoning, if the Force directed to the Center be at any time at Right Angles or leſs than Right Angles with the Line in which the Body would run out, it muſt ſtill continue to be ſo; and while it is ſo, the Body muſt move every time the Force acts, or continually, from a Point more diſtant from *S*, to a Point leſs diſtant from *S*, or approach nearer to *S*. But if a Curve be ſuch, that the Lines in which the Body would run out, *viz.* the Tangents of the Curve, make with the Radius conſtantly more than Right Angles; then is the Body that moves in that Curve moving continually away from *S*: Or if the Tangent and Radius of this Curve at any time be at Right Angles, or leſs than Right Angles, then muſt the moving Body come conſtantly nearer to the Center *S* in a Spiral Line. *Q. E. D.*

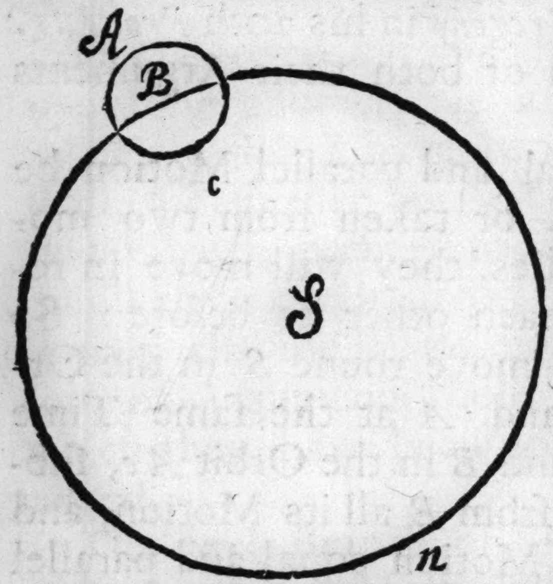
COROLLARY.

Hence it appears that neither the Planets, nor their Satellites, nor the Comets, are turn'd from the ſtreight Lines they would neceſſarily deſcribe, by a Centripetal Force; becauſe the Tangents of them all have been obſerved at right Angles, or leſs than right Angles with the Radius; and they have not moved conſtantly nearer to that Body to which the Radius is directed. Or rather the Planets, and their Satellites, and the Comets, are not turned from ſtreight Lines by a Centripetal Force; becauſe they neither move continually away from the Bodies round which they revolve, nor come conſtantly nearer to them in a ſpiral Line.

Since Mr. *Newton*'s Natural Philoſophy extends no further than to what concerns the Syſtem of the Univerſe; and his whole Scheme of the Syſtem of the Univerſe is built upon this Propoſition, which I have diſproved; and ſuppoſes the whole Bodies of that Syſtem to move by Centripetal Force, which I have demonſtrated to be impoſſible: What I have ſaid is ſufficient to overturn his whole Scheme. But ſince all his other Reaſonings beſide their Dependance upon this Argument, which I have diſproved, or their Dependance upon one another, are as defective as this which I have conſider'd; I ſhall, for further Satisfaction upon this Subject, proceed to remark upon all the main Branches of his Reaſoning, that the World may ſee what ſort of Arguments thoſe are, with which they have been ſo long deceived.

The next Branch of his Reaſoning upon this Subject, is his Proof, That in the Caſe of a Body, round which another revolves, being in Motion, the Body deſcribing round it Areas proportionable to the Times, is forced into its Motion by all the Force by which that Body round which it deſcribes thoſe Areas is moved, and beſide that by a Centripetal Force directed to that Body. This Caſe, as I obſerved before, is diſtinguiſh'd from the other by Dr. *Gregory*; and his Way of propoſing this Argument ſets it in a clearer Light. Mr. *Newton* proves this Point in his 2d and 3d *Pro. L.* 1. and Dr. *Gregory* in his 20th *Pro. L.* 1. The Sum of both their Arguments is,

If equal and parallel Motion be deſtroyed or taken from two moving Bodies, they will move in reſpect of each other as before: *So* that if *B* move round *S* in the Orbit *B n*, and *A* at the ſame Time move round *B* in the Orbit *A c*, ſubſtracting from *B* all its Motion, and from *A* a Motion equal and parallel to all *B*'s Motion, then will *A* continue to deſcribe round *B* the Orbit *A c* as before; but if in deſcribing *A c*, it deſcribe round *B* at reſt Areas proportionable to the Times; by the Proof of the former Caſe, the Force by which it is moved is directed to *B*; but its Motion conſiſted at firſt of what was deſtroyed, and what remains. And what was deſtroyed being a Motion equal and parallel to all *B*'s Motion, was produced by all the Force that produc'd *B*'s Motion; Effects being proportionable to their Cauſes. So that all the Force by which *A* moves, is all the Force by which *B* moves, and a Force directed to *B*.



I have nothing to ſay againſt this Demonſtration, as depending upon the former; my Deſign being only in every Argument to obſerve what Fault is peculiar to it: So that in conſidering this and all other of our Authors Arguments, I ſhall ſtill ſuppoſe all former Propoſitions fairly demonſtrated. This being premiſed, the Fault of this Demonſtration, which I ſhall firſt obſerve, is much of the ſame kind with the firſt I obſerved in the former, *viz.* It is poſitively affirmed of *A* that its Motion is produced by the Force that produces *B*'s Motion, and by a Force directed to *B*, and only proved that *A*'s Motion might poſſibly be produced by ſuch Forces.

It is plain that the real Motion ſuppoſed to be performed by *A*, may be ſuppoſed divided into two Motions different from theſe two in which it is ſuppoſed divided, *viz.* different from the Motion of *B*, and a Motion round *B*, as well as it may be ſuppoſed divided into thoſe Motions. And then by our Author's Reaſoning, the Cauſes of theſe two different Motions muſt be proportionable to the Effects, and conſequently different from the Cauſes aſſign'd; and ſince there are infinite Numbers of poſſible Diviſions of any Motion, ſo are there infinite Numbers of different Cauſes, which by this Way of Reaſoning may be proved to be the Cauſes of this or any other Motion. So that all that is here proved, and all that ought to have been here aſſerted, is, that the Motion in Queſtion may be accounted for from the given Cauſes; and then, as I obſerved before, if there had not appear'd ſome Inconvenience in admitting that to be the Cauſe, this Argument might have been of Uſe in Phyſicks: But the chief Thing here to be obſerved is, that there is an Inconvenience in admitting this Cauſe to be the Cauſe of that Motion; ſo great and ſo evident, that it could not poſſibly have been overlook'd, if Men's Inquiry after the Inconveniences of admitting this Cauſe had not been laid aſleep by the ſhew of a poſitive Demonſtration, that this is the Cauſe of the given Motion; nay the Inconvenience in admitting it to be ſo, is ſo extreamly obvious, that there was a Neceſſity for uſing another Art to conceal it, *viz.* not ſo much as to mention one part of this Cauſe, the very Name of which would have diſcovered the Abſurdity.

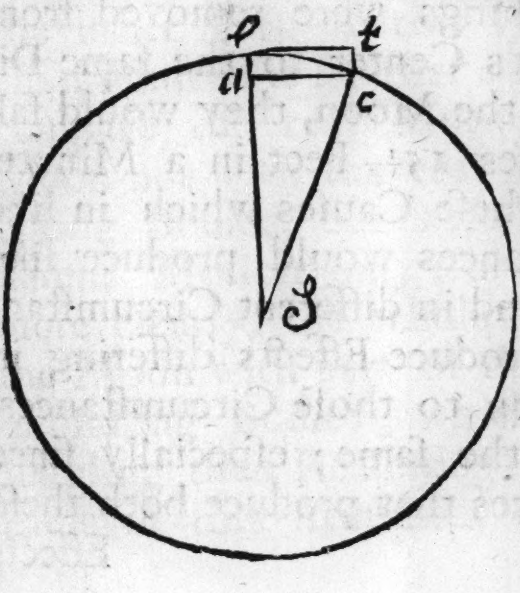
For making all this appear, let us conſider that the Cauſe of *B*'s Motion round *S*, which is the one part of *A*'s Motion, is according to the Proof of Caſe 1ſt, a Force by which the Body, by the Nature of Bodies in Motion, endeavours to run out in all the Tangents of the Curve *Bn*, and a Centripetal Force directed to *S*. The other Part into which *A*'s Motion is divided, *viz.* a Motion in the Curve *Ac* round *B* at Reſt, by the Proof of Caſe firſt, is produced by a Force with which the Body endeavours to run out in all the Tangents of the Curve *Ac*, and a Centripetal Force directed to *B*: Now both our Authors take very good Care not to mention in this Place that half of their Cauſe, which conſiſts in the Endeavour of the Body to run out in Tangents; which if they had not done, the Abſurdity of ſuppoſing the Cauſe of any Body's Motion to be an Endeavour in the Body at every Inſtant of time to run out in two different Lines, (as the Tangents of thoſe two different Curves are) at the ſame Time, is ſo very groſs and evident, that it could never have been ſwallowed by any Man of common Senſe.

From this, it's plain, I might draw a Mathematical Demonſtration, *a priori*, independent of the former Demonſtration, proving that *Satellites* in particular are not moved by a Centripetal Force; but the former Demonſtration does this ſo clearly, that any more Proofs were abſolutely needleſs; and beſide, my Deſign in this Place is only to obſerve the chief Faults of the main Branches of the Reaſoning that ſupports Mr. *Newton*'s Philoſophy.

Mr. *Newton*, *Pro.* 4. *L.* 3. affirms, That the Force by which the Moon is hinder'd from running out in ſtreight Lines and kept in her

Orbit, is the ſame with that Force by which heavy Things fall to the Ground; and Dr. *Gregory*, in his 46th *Prop. L.* 1. aſſerts the ſame, and their Demonſtrations are alike, *viz.*

The Moon's middle Diſtance is 60 Semidiameters of the Earth by Calculation; it appears alſo by Calculation, that ſhe deſcribes in a Minute the Arch *l c*, whoſe Verſe Sine *la* is 15$\frac{1}{12}$ Feet; ſo that in deſcribing that Arch, or in a Minute ſhe falls from her Tangent *l t* the Space *tc*=*la*, that is 15$\frac{1}{12}$ Feet. Now the Force which makes the Moon fall from her Tangents being in different Diſtances, as the Squares of thoſe Diſtances would force her if upon the Surface, or at the Diſtance of 1 Se-



1 Semidiamiter to move in a Minute a Space which is to $15\frac{1}{12}$ Feet as the Square of 60 to the Square of 1, *viz.* $60\times60\times15\frac{1}{12}$ Feet in a Minute; but it is found by exact Experiment that heavy Things with us, at the Diſtance of 1 Semidiameter, fall $15\frac{1}{12}$ Feet in a Second; and it's well know that they accelerate their Motion in falling in a Duplicate Ratio of the Time of falling: So that in a Minute, or 60 Seconds, they muſt fall $60\times60\times15\frac{1}{12}$ Feet, the very ſame Space the Moon would fall at the ſame Diſtance. And by inverting the ſame Computation, if heavy Things were removed from the Earth's Center to the ſame Diſtance as the Moon, they would fall as ſhe does $15\frac{1}{12}$ Feet in a Minute. So that theſe Cauſes which in like Circumſtances would produce like Effects, and in different Circumſtances do produce Effects differing in Proportion to thoſe Circumſtances, muſt be the ſame; eſpecially ſince both Forces that produce both theſe

Effects are directed to the ſame Center.

Mr. *Newton* adds another Reaſon in the latter End of his Demonſtration, *viz.* That the Cauſe which turns the Moon from her Tangents muſt be the ſame with that Cauſe which forces heavy Things toward the Center; becauſe if thoſe Cauſes were different, both together would force Bodies to fall $30\frac{1}{6}$ Feet in a Second contrary to Experience. But this Reaſon Dr. *Gregory* very judiciouſly omits; and it's ſtrange that ſo plain a *petitio principij* ſhould have eſcaped Mr. *Newton*'s Pen! As for the other Part of this Proof, the chief Fault of it is, that our Authors compare the real Motion of the Moon not with the real Motion of falling Bodies, but with their apparent Motion only: or to ſpeak more clearly, the whole Motion of the Moon with part of the Motion of falling Bodies; which is liker Juggling than Reaſoning: And this Fault in this Argument is of the greateſt Conſequence, becauſe the Nature of the Argument is, from the Likeneſs of Effects, to infer that thoſe Effects are produced by the ſame Cauſe.

It appears very clearly that the real Motion of the Moon is compared with the apparent Part of the Motion of falling Bodies only, even from what Mr. *Newton* himſelf ſays; for he acknowledges that his Calculations of thoſe Motions depend upon the Suppoſition of the Earth being at Reſt. Now ſince the Earth appears to us at Reſt, and we are altogether inſenſible of its Motion, and conſequently of the Motions of Things that accompany the Earth in its Motion; it's plain that this Part of the Motion of falling Bodies which they perform in accompanying the Earth, though it be a real Motion, is to us inſenſible; and that Part of the Motion of a falling Body by which it differs from the Earth's Motion, is all that appears to us, and all that our Author brings into his Calculation,

tion, ſince he ſuppoſes the Earth to be at Reſt. It's true, in calculating theſe Motions, there was no need of taking into the Calculation that Part of the real Motion of the Moon or of falling Bodies, by which they accompany the Earth in its Orbit; becauſe this Motion is in the Moon, and falling Bodies perfectly equal; and whether we take this Part of their Motion into the Account or leave it out, the Difference of theſe Motions will be the ſame. So that if Mr. *Newton* had only ſuppoſed the Earth at Reſt from the Motion in its Orbit, his Reaſoning had been fair; but he ſuppoſes alſo the Earth at Reſt from the turning upon its Axis; as appears by his leaving out of his Account of the Motion of a falling Body that Part of its Motion which depends upon the Earth's Diurnal Rotation; and compares only the remaining Part of the Motion of falling Bodies with the Moon's whole Motion. So that if what Mr. *Newton*

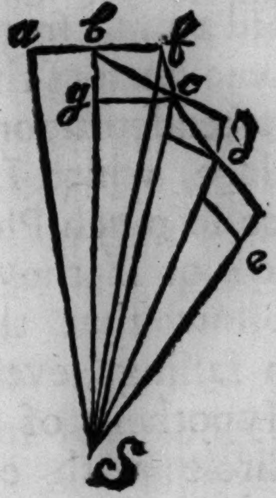
ton pretends to demonſtrate by his Calculation be true, *viz.* that the Part of a falling Body's Motion which he conſiders is the full adequate Effect of ſuch a Cauſe as that which turns the Moon in her Orbit; then does he fully demonſtrate that a different and greater Effect cannot poſſibly be produced by that Cauſe. Now that the Effect of the Force which drives falling Bodies from running out in ſtreight Lines, is more than what he conſiders, is thus evident.

The Earth by turning upon its Axis would certainly throw out all Bodies lying looſe upon its Surface in Tangents; or rather thoſe Bodies being in Motion would by the Nature of Motion neceſſarily run out in thoſe ſtreight Lines, as well as the Moon would run out in the Tangents of her Orbit, if ſome Force did not hinder them: And if Gravitation were a Force that did no more than hinder Bodies from running out in Tangents, then it might in my Opinion be very reaſonably thought to be the ſame with that Cauſe which hinders the Moon from running out in Tangents. But ſince Gravitation not only forces heavy Things to fall ſo far from their Tangents as to keep into a revolving Orbit, but likewiſe forces them to endeavour always to run within this Orbit toward the Center in a Spiral Line; it ſeems very unlikely that this is that ſame Cauſe which turns the Moon and other Planets; ſince that Cauſe, whether acting near or far from that Body from which it is ſuppoſed to proceed, ſtrictly obſerves this Law, never to force any Bodies upon which it acts within their revolving Orbit; which on the contrary Gravitation always does. And certainly if Likeneſs of Effects be a Proof that they proceed from the ſame Cauſe, their Unlikeneſs is a much ſtronger Proof that their Cauſes cannot be the ſame; and conſequently, I have much better Reaſon dogmatically to affirm that the Cauſe which turns the Moon in her Orbit, and that which forces heavy Things to fall, is not the ſame, from having ſhew'd their Effects to be different, than Mr. *Newton* had to affirm them to be the ſame from the Likeneſs of Effects, though he had fairly demonſtrated this Likeneſs. For Cauſes that are not the ſame may produce like Effects; but the ſame Cauſe cannot produce unlike Effects. But I am not fond of dogmatical Affirmations in Phyſicks, neither is it my Deſign in this Place to affirm any thing; but to examine the Reaſons our Authors bring to juſtify their Aſſertions. So that I ſhall content my ſelf with making appear that our Authors Demonſtration, if it demonſtrate any thing, demonſtrates the Contradiction of that Aſſertion, for proving of which it is adduced.

For making of this more fully appear, let us conſider that the $15\frac{1}{12}$ Feet which our Author affirms to be the Space a falling Body is forced by Gravitation to move in a Second, is that Space which it moves upon the Suppoſition of the Earth being at Reſt, or that Space which it appears to us to fall in a Second: And it's alſo certain that beſide this Space of $15\frac{1}{12}$ Feet in a Second which it appears to us to fall, it does really fall a Space in a Second equal to that Space which we and all other Things that to us appear at Reſt do really fall, toward the Earth's Center, from thoſe Tangents or ſtreight Lines into which we muſt neceſſarily run out, if Gravitation did not hinder us and force us from theſe Tangents. So that, according to our Authors Way of computing, a falling Body falls in a Second a Space equal to the Verſe Sine of an Arch of the Earth's Circumference of $17'' + 15\frac{1}{12}$ Feet; and if his Proof that the falling $15\frac{1}{12}$ Feet in a Second is the full Effect, that the Cauſe which turns the Moon in her Orbit would have if it acted upon the falling Body, certainly the falling $15\frac{1}{12}$ Feet $+$ the Verſe Sine of the ſaid Arch, which is the real Effect of Gravitation, cannot poſſibly be produced by that Cauſe; and therefore Gravity, the Cauſe that produces this actual Motion, muſt be different from that Cauſe that turns the Moon in her Orbit.

I cannot paſs over this Point without obſerving another Fault in this Demonſtration, *viz.* That our Authors affirm the Moon to fall from her Tangents a Space equal to the Verſe Sine of any Arch in deſcribing that Arch; that is to ſay, they condeſcend upon a certain Tangent, and conceive the Moon to be continuing to fall from that Tangent; notwithſtanding that in Reality a Body moving in a Curve endeavours to run out in the Tangents of every Point of that Curve, and muſt by a Force acting upon them, in every Point of their Motion, be forced from theſe Tangents. So that in Reality it is from all poſſible Tangents a Body moving in a Curve falls, or is really drove by that Force which forces it to de-

deſcribe a Curve; as appears clearly from our Authors Account of a Curve, which I have repeated above, *viz.* The Body deſcribing the Curve *abcde*, in the Points *b*, *c*, *d*, and *e*, is forced from the Tangents of every one of thoſe Points; and in deſcribing *b c*, falls from *b f* the Tangent of *b*, the Space $cf=bg$; and in performing, *c d*, falls from the Tangent of the Point *c*, as before from the Tangent of the Point *b*; and in performing any Number of ſuch Motions, falls from that Number of Points the ſame Number of ſuch Spaces. If this be deny'd, and if it be aſſerted that a Body moving in an Orbit continues to fall from one Tangent, I ask where is that Tangent from which it falls? Or how comes it, when it has deſcribed a Semicircle, to leave



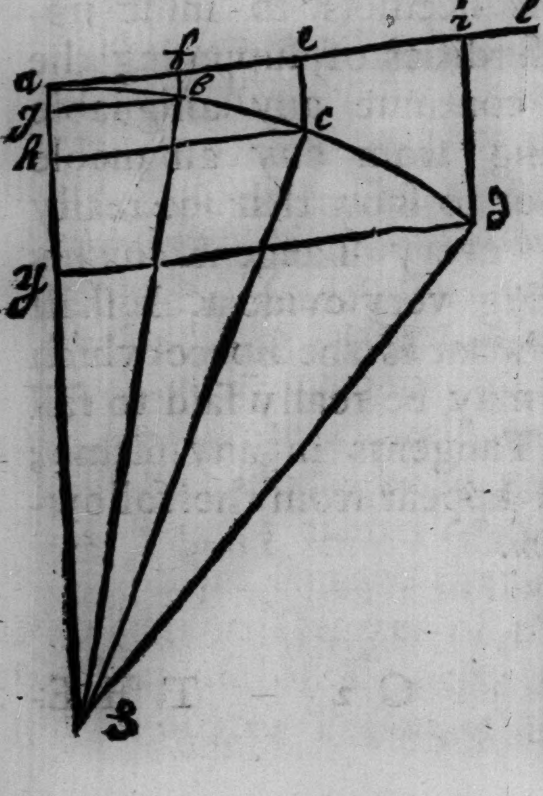
off falling and begin to riſe to that Tangent again? Since in the Senſe it can at any time be ſaid to fall from its Tangents, it can always be ſaid to fall from them. At this rate ſome part of the Orbit muſt be condeſcended upon to be the uppermoſt Place, which I believe our Authors are ſo much Philoſophers as not to do; or if they would, then will it follow that the Moon accelerates in falling, even upon our Authors Hypotheſis of her Motion being a Circle with equal Velocity, *viz.* that the Velocity of her falling Motion encreaſes in a Proportion to the Times of falling, as the Verſe Sines of Arches to their Arches. And it is very ſtrange, if any part of a Motion ſo uniform and equable as the Motion in a Circle with equable Velocity, ſhould be ſo variable and accelerate in ſuch Proportion; but much more ſtrange that after compleating 90 Degrees of this Circle, the Increaſe of Velocity ſhould begin to abate. Beſide, if all this be true, then it is not true that in any Minute of the Moon's periodical Time, ſhe falls $15\frac{1}{12}$ Feet; for at this rate ſhe only falls juſt ſo much the firſt Minute ſhe begins to fall from the Tangent of her higheſt Point, and in that Minute before ſhe come to her loweſt Point; and in all other Minutes in that Part of her Orbit where ſhe falls, ſhe falls more then $15\frac{1}{12}$ Feet.

But it is needleſs to inſiſt upon the Abſurdities of ſuppoſing the Moon to continue any aſſignable Time falling from any aſſignable Tangent; or to ſhow that ſhe really falls from every Tangent. This Matter being very evident, I ſhall next ſhow what is the Space which the Moon may be really ſaid to fall from her Tangents in any Time; which will appear from the following *Theorem.*

THEOREM II.

A Body deſcribing any Arch a d, *really falls from the Tangent of every Point of that Arch a certain Space, and the Sum of all thoſe Spaces is, in Reſpect of the Verſe Sine of* a d, *infinitely little.*

Suppoſe *a d* divided into equal Parts *a c* and *c d*; ſuppoſe alſo the Force turning the Body into this Curve to act in the Points *a* and *c*, the Force acting in *a*, forces the Body to fall



fall from the Tangent of the Point *a*, the Space *e c*; and another Force equal to the former acting at *c*, forces the Body from the Tangent of the Point *c* a Space equal to *e c*. So that if the Arch *a d* be ſuppoſed performed by two Puſhes of a Force acting in two Points *a* and *c*, the Space the Body will fall by theſe Puſhes, *viz.* 2 *e c* is not ſo great as the Space *i d*, which it would have fallen from the Tangent *a l*, if it had been forced to deſcribe *a d* by the Force *a y*: Or which is all one, the Force *a h*, twice repeated at the Points *a* and *c*, that is, 2 *a h* is leſs then *a y*. And if again we ſuppoſe the Arch *a c*, produced by two Forces acting in the Points *a* and *b*, the Sum of theſe two Forces or the Sum of their Effects, *viz.* the Spaces which they force the Body to fall from the Tangents of the Points *a* and *b*, are leſs than the Force *a h*, or the Space *e c*: Therefore if the Arch *a b c d*, be ſuppoſed produced by three Forces acting in the Points *a*, *b*, and *c*, the

Sum of theſe three Forces or the Sum of their Effects, *viz.* the Spaces they force the Body to fall from theſe three Tangents, is leſs than when this Arch was ſuppoſed to be produced by two; and ſo the more Points the Force be ſuppoſed to act in, the leſs is the Sum of thoſe Forces or the Sum of the Spaces which they force the Body to fall from its Tangents, if compared with *a y* or *i d.* And ſince it appears plainly both from our Authors Way of accounting for a Curve from a continuing Force, and from what I have already ſaid, that a Body moving in a Curve really endeavours to run out in ſtreight Lines at every Point, that is, at an infinite Number of Points; and the continuing Force really acts in all theſe Points, and at every Point forces the Body from the Tangent of that Point; and ſince I have now ſhewn that the Sum of the Spaces, which a Body forced from Tangents by a Force acting in different Points falls from thoſe Tangents, diminiſhes as the Number of Points in which this Force is ſuppoſed to act increaſes. The Sum of the Spaces, which this Force that acts in one infinite Number of Points forces the Body to fall from all its Tangents in deſcribing the Arch *a d*, is to the Space *i d*, or its Equal *a y*, infinitely little.

COROLLARY.

Hence it appears that all Eſtimates of the Quantity of a Force turning a Body from ſtreight Lines into a Curve, if they meaſure the Force that produces any aſſignable Arch by the Verſe Sine of that Arch, or compare the Forces that produce any two Arches, one whereof is greater than the other, by the Verſe Sines of thoſe Arches, are erroneous.

Mr. *Newton*, in his 5th Prop. L. 3. and Dr. *Gregory*, in his 47th Prop. L. 1. aſſert that the Cauſe which keeps all the Planets, both Primary and Secondary, in their Orbits, is the ſame with the Cauſe that keeps the Moon in her Orbit, *viz.* Gravitation: And though I am inclined to think the Cauſe that keeps the Primary Planets in their Orbits round the Sun, to be ſomewhat different from that which keeps Secondary Planets in their Orbits round their Primaries; yet I do not ſee any ſo great Fault peculiar to this Propoſition as to have mentioned it, were it not that both our Authors draw from it a very important Corollary, which will by no means follow. This Corollary is, That ſince the Secundary Planets gravitate upon their Primaries, and the Primary Planets upon the Sun, Action and Re-action being mutual, the Primary Planets muſt alſo gravitate upon their Satellites, and the Sun upon the Primary Planets.

In drawing this Corollary, it's evident that our Authors ſuppoſe their Gravitation to be the Action of thoſe Bodies to which that Force is directed; for proving of which, they offer not ſo much as to ſhew one Argument, but ſuppoſe it only; and therefore no more is requiſite for overturning this *gratis dictum*, but to deny this Force to be the Action of thoſe Bodies to which it is directed, or at leaſt to deny that it appears to be ſo.

But that I may not here be thought to deny a Thing that is very probable, for no Reaſon, but becauſe it is not prov'd: I ſhall ſhow that what is ſuppoſed in this Corollary, is not only improbable, but inconſiſtent with all thoſe Laws of Nature that have ever been diſcovered by any Man beſide Mr. *Newton* and his Followers. In order to which, let us diſtinguiſh betwixt the mediate and immediate Action of Bodies. The firſt is, when the Action of one Body is communicated to another by ſome intermediate Agent; as when I throw a Stone againſt the Wall, I act upon the Wall by the Means of the Stone. The ſecond is, when one Body, without the Intervention of any other Being to aſſiſt it, acts it ſelf upon another Body; and in this Senſe it never did appear that Bodies could act upon one another otherways than by Touch; and it is from the Nature of Touch, which cannot but be equal and mutual, that this ſort of Action, which can only be properly called the Action of Bodies, is neceſſarily mutual. The firſt kind of Action is not properly Action; but only a Way of ſpeaking accommodated to the Ways of thinking of the Vulgar: For when a Man throws a Stone againſt the Wall, his Hand acts upon the Stone, and not upon the Wall; and the Stone acts upon the Wall. Juſt ſo a Horſe that pulls a Stone, which is faſtned to him by a Rope, only pulls or acts upon the Rope; and it depends upon the Nature and ſtrong Coheſion of the Rope, that it is fit to communicate this Action to the Stone. When Bodies act immediately upon each other by Touch, then is Reaction equal and of a contrary Direction by a Phyſical Neceſſity; but when Bodies act mediately upon each other, then is Action and Reaction mutual or not mutual, according to the Nature of that which conveys the Action of one Body to the other; as the two foregoing Inſtances ſufficiently ſhow: For if a Horſe is faſtened to a Stone by a Rope, and this Rope be ſtrong enough and no other Thing hinder, this Rope will communicate to the Stone the Action of the Horſe, and the ſame Rope will communicate to the Horſe the Reaction of the Stone: But then, in the other Inſtance of a Man throwing a Stone againſt the Wall, there is no Neceſſity in Nature that the Wall ſhould throw another Stone at him again. Now ſince Mr. *Newton* ſays that his Cauſe proceeds from Bodies, and penetrates other Bodies; and ſince it is not to be ſuppoſed that he means to aſſert that Bodies proceed from themſelves and penetrate each other, we may ſafely conclude that his Cauſe, or that whatever it be that thus penetrates, acts, and impreſſes upon Bodies this Force directed to each other, is a Being different from the Bodies themſelves; and if ſo, all the Reaction that is in this Caſe neceſſary, is that the Bodies which are acted upon by this Inſtrument of Attraction, muſt react upon that Inſtrument, provided the Author of it will ſuppoſe it to be ſuch a Being as can be reacted upon by Bodies. This Inſtrument may alſo be ſuppoſed fit to communicate to that Body from whence it proceeds this Reaction of thoſe Bodies that react upon it. But then it is plain that this would not be Proof, which our Author pretends, but Hypotheſis only; and ſuch an Hypotheſis would be preſſed with many and great Difficulties, which it is not my Buſineſs here to ſhow. All I am concerned to do, is what I have already done, *viz.* to make appear that our Author's Reaſons do not prove his Aſſertions.

It's ſtrange he did not rather chuſe to prove the Mutualneſs of Attraction in the Stars from the Likeneſs of the Nature of thoſe Bodies, than from the general Law of Action and Reaction; ſince it is from this Likeneſs, and not from the Law of Action and Reaction, that all natural Attractions which are mutual do proceed. For Inſtance: The Attraction of two Loadſtones; the Actions as well as Reactions of which Bodies appear to depend upon ſomething particular in their own Nature, different from that Part of their Nature common to them and all other Bodies, by which they act and react upon any Body whatever. And two Stars being as like, and to be ſuppoſed of one Nature as much as two Loadſtones; ſince our Author proves one of them to attract the other, or to ſend forth ſomething that penetrates its Subſtance, and puſhes that other toward it; why might not he from the Likeneſs of the Nature of thoſe Bodies infer, that this other Body would ſend forth ſome ſuch Thing to attract it? This Way of Reaſoning would have carry'd in it ſome Probability, and conſequently might very well have been uſed in Natural Philoſophy.

But our Author makes uſe of no probable Reaſonings; he had a Mind to ſecure his Philoſophy from all Cavils and Diſputes, by aſſerting nothing without full and abſolute Demonſtration, or at leaſt not without ſomething dreſſed up like ſuch, as he himſelf tells us * in his Introduction to his third Book; which contains his Philoſophy. He foreſaw in general, that his Philoſophy would be called in Queſtion, and objected againſt, if without that Security; and to this particular probable Argument, if he had uſed it, many Objections might have been

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* *Ne res in Diſputationes trahatur Summam Libri; tranſtuli in propoſitiones more Mathematico.*

made, *viz.* Though in the Caſe of the Attraction of the Loadſtone and ſome others, Attraction may appear to be mutual; yet in ſome Attractions this does not appear. It might alſo have been univerſally denied of all Attractions, that the Force, or that which impreſſes the Force, appears to proceed from thoſe Bodies to which this Force is directed, which are ſaid to perform this Attraction in the common Way of ſpeaking; and this can never be proved. Nay, an Attraction, as properly ſo called as any other, may be inſtanced, in which it appears that the Force, or that which impreſſes the Force, proceeds not from that which is ſaid to attract, and the Attraction appears alſo not to be mutual, *viz.* that Attraction by which a Void draws or ſucks into it Air, Water, *&c.* And yet, this ſame Attraction, which is of ſo very different a Nature from our Author's, may by as good Argument as the Nature of the Subject will allow be proved very like ſome part of that Force which hinders the Primary Planets from running out in Tangents. But to do this, is not proper in this Place. And whether this can be done or not, ſtill from what has been ſaid it appears, that if our Author had uſed the probable Argument I mention'd, or if any Man think fit to uſe it in his Behalf, yet there might have been more Objections made againſt it, than would have ballenced its Probability; but however, if he had uſed that Argument, it would ſtill have had ſome Weight, whereas what he urges can be of no manner of Uſe.

Mr. *Newton* draws another Corollary from his 5th Prop. and the Corollary I ſpoke of, *viz.* That all the Planets gravitate upon each other; and infers from this, that when near one another, they muſt neceſſarily diſturb each others Motions, as ſome of them appear to do. But this Diſturbance that appears, if rightly conſider'd, will appear liker the Effect of a Power in thoſe Bodies mutually to drive away, than mutually to attract each other. But this I leave to Aſtronomers. As for the Corollary itſelf, I cannot ſee how it follows from the Propoſition or former Corollary; and our Author ſays nothing to ſhow the Connexion of this Corollary with any of them, nor gives any Reaſon for his drawing ſuch a Corollary: Neither can I find any Reaſon he had for ſo doing, but to honour his own Invention, and dignify his Cauſe with the Title of *Catholick* and *Univerſal*, which appears from his 6th and 7th Prop. which depend upon this Corollary, wherein he aſſerts univerſally of all Bodies whatever that they attract each other.

He aſſerts alſo in theſe Propoſitions, That the Force of his Attraction acting upon different Bodies which are at the ſame Diſtance from the attracting Body, is as the Quantity of Matter which thoſe Bodies contain: His Proof of which is to this Purpoſe.

It appears univerſally in all Bodies that gravitate upon any other Body, that whatever their Bigneſs or Quantity of Matter be when at like Diſtances from the attracting Body, they fall equal Spaces toward it in equal Times, or fall to it with equal Velocity, and the Force that accelerates Bodies of different Quantities of Matter equally, being as their Quantity of Matter; This Force, which thus accelerates Bodies of unequal Quantity of Matter equally, muſt be as the Quantities of thoſe Bodies. Moreover, all the Parts of thoſe Bodies muſt neceſſarily attract with a Force proportionable to their Quantity; for if any Sort of Parts in a Planet attracted more or leſs than in Proportion to their Quantity, the whole Planet would attract more or leſs than according to its Quantity, as it moſt abounded of the one or other Sort of theſe Parts.

This Proof has ſo many, ſo great, and ſo evident Defects, that it ſcarce deſerves the Name. Some of the moſt obvious of them, I ſhall mention; and enlarge upon that only, which to me ſeems moſt conſiderable.

It's plain then, in the firſt Place, that the Queſtion is here begg'd, and the Attraction of a Planet ſuppoſed to be made up of the Attractions of its Parts; for though it may be thought that the Earth attracts its Parts, becauſe they fall to it, yet I challenge any to ſhow from any Appearance that thoſe Parts attract any Body in Nature, or any ways produce upon them any ſenſible Effect which may be attributed to their Attraction.

It's here alſo ſuppoſed, that Planets of unequal Quantity of Matter gravitate equally; when only the Difference of Bulk and not Quantity appears, which are very different.

But the chief Fault of this Argument is, that it depends upon this Aſſertion, that Forces which produce a Motion of equal Velocity in Bodies of unequal Quantity are as the Quantities of thoſe Bodies; which is apparently falſe, and as far as I can ſee, has not the leaſt Shew of Truth; For Inſtance, Two Ships of unequal Bigneſs and Quantity, carried by the Stream of a River, are brought into a Motion of equal Velocity, by the Force of the Preſſure of the Water: And certainly the Force of any Quantity of Water that preſſes upon the one Ship, is equal to the Force of an equal Quantity of the Water that preſſes upon the other; and conſequently, the Force of all the Water that preſſes upon the one Ship, is to the Force of all the Water that preſſes upon the other, as that Part of their Surfaces upon which the Water preſſes, which in Ships of different Quantity might be made equal; nay, the Quantity of that Part of the Surface upon which the Current preſſes might be made greater in the ſmall Ship than in the big one: Or, if our Author does not mean the Quantity of Force, but its Velocity, or *Vis Acceleratrix*, as he calls it, then is this preciſely equal in our Inſtance, for the Water preſſes the great Ship and ſmall with a Force of equal Velocity.

There may be innumerable Inſtances of this kind; ſuch as the ſame Wind which drives unequal Clouds with equal Velocity. A Body of 100 Pound Weight, in a Motion of any given Velocity, ſtriking upon a Body of 10 Pound, and upon another of 50 Pound, will bring theſe unequal Bodies into a Motion of equal Velocity, though it acts upon their Surfaces only, and that with a Force the ſame, both in Quantity and Velocity, *viz.* All the Force and Velocity with which it ſelf moves, for it can give no more Velocity to the ſmalleſt than it has, and it will be able to put the greateſt into a Motion of a Velocity equal to that in which it ſelf moves.

But what need we ſpend Time in giving Inſtances of this, ſince all Bodies of unequal Quantity of Matter moving with equal Velocity, (where it appears by what Force they are moved) appear to be moved by Cauſes that act upon their Surfaces only; and almoſt all thoſe Bodies appear alſo to be moved by Forces which are either equal or not in Proportion to the Quantities of thoſe Bodies. So that I proteſt I cannot ſee what has drawn our Author into ſuch a Miſtake, as to infer from the equal Velocity of the Motions of Bodies differing in Quantity, that thoſe Motions muſt be produced by Forces proportionable to theſe different Quantities; and again from that to infer that this Force muſt act upon the whole Subſtance of Bodies. Nor can I ſee how it comes that ever any Man of good Senſe could think that theſe Inferences were fair, or be induced by this Argument to frame an Idea ſo very ſtrange, as that of a Cauſe penetrating and acting, not upon the Surface, but upon the whole Subſtance of Bodies. But to proceed,

Both our Authors aſſert in ſome of thoſe Propoſitions which I have conſidered, that the Force which turns the Stars in their Orbits, in different Diſtances from thoſe Bodies round which theſe Orbits are deſcribed, is as the Squares of thoſe Diſtances. And this Part of theſe Propoſitions I have not taken Notice of, becauſe I cannot ſay but the Cauſe which turns the Stars in their Orbits may be ſuch; nay, I am inclined to believe it to be ſuch. And therefore though the Arguments our Authors uſe to prove this be very weak, yet it were critiſizing upon thoſe Authors (which I have no Mind to do) rather than handling my Subject, to remark upon thoſe Arguments.

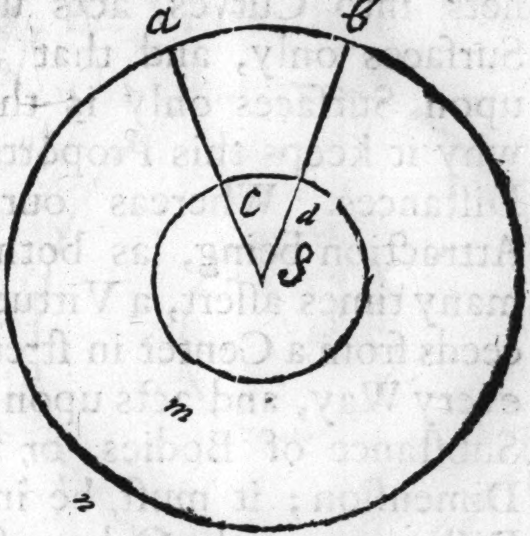
That which concerns my Subject in this Point, is their Aſſertion, that Attraction is ſuch a Force as at different Diſtances is as the

Squares of thoſe Diſtances; becauſe the Proof of this Aſſertion proves their Cauſe to be in that Reſpect like the true Cauſe, and ſo yields ſome Probability of its being the true Cauſe.

This Point Mr. *Newton* no where proves; but aſſerts or ſuppoſes only; but Dr. *Gregory* proves it Prop. 48. This Propoſition aſſerts,

That the Force or Efficacy of any Virtue (ſuch as Attraction) which ſpreads it ſelf either to or from a Center in ſtreight Lines, through all the Space that ſurrounds that Center, muſt in different Diſtances from the Center be as the Squares of thoſe Diſtances. His Demonſtration is,

It's plain that any Quantity of this Virtue being ſcatter'd equally through a greater Space, and the ſame Quantity being ſcatter'd equally through a leſſer Space, there will be of this Virtue in any given Part of the greater Space a Quantity, which is to the Quantity of it that is in an equal Part of the leſſer Space, as the leſſer Space to the greater. It's plain alſo, that the Force or Efficacy of this Virtue in any two Places, is as the Quantity of it that is in thoſe Places. Let *S* be the Center; deſcribe round *S* the two Spherical Surfaces *a b n* and *c d m*; draw the Lines *aS* and *bS*. The ſame Quantity of this Virtue that is ſpread through the Spherical Surface *c d m*, is alſo ſpread thro' the Spherical Surface *a b n*; therefore in any Part of the Surface *c d m*, the Force of this Virtue is to its Force in an equal Part of *a b n*, as *a b n* to *c d m*; but *a b n* is to *c d m*, as the Squares of the Circles *a b n* to *c d m*; which are



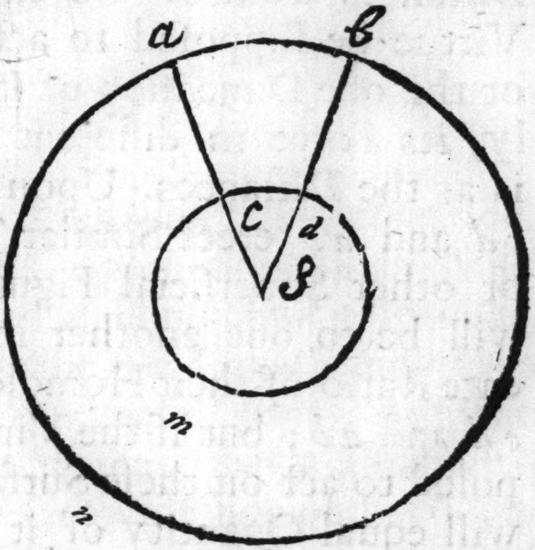
as the Squares of the Radij *aS* and *cS*: viz. The Diſtances of the Surfaces *cdm* and *abu*.

For my part, I believe this Propoſition to be both very true and very fairly demonſtrated of all Virtues that act upon Bodies, and proceed to or from a Center in ſtreight Lines; but then, I believe this, only becauſe I alſo believe that no ſuch Virtue can act upon any more than the Surfaces of Bodies, and that the Cauſe which forces the Planets into Curves, acts upon their Surfaces only, and that its acting upon Surfaces only is the Reaſon why it keeps this Proportion to the Diſtances. Whereas our Authors Attraction being, as both of them many times aſſert, a Virtue that proceeds from a Center in ſtreight Lines every Way, and acts upon the whole Subſtance of Bodies, or their trine Dimenſion; it muſt be in different Diſtances, as the Cubes of thoſe Diſtances, which I ſhall demonſtrate in the following *Theorem*.

THEOREM III.

The Force or Efficacy of any Virtue, which ſpreads it ſelf in ſtreight Lines through all the ſurrounding Space equally to or from a Center, and acts upon the whole ſolid Content or trine Dimenſion of Bodies, muſt in different Diſtances from that Center be as the Cubes of thoſe Diſtances.

Suppoſe the Virtue that is ſpread to or from the Center *S*, to act upon Lines or the one Dimenſion only, *viz.* the Circles *c d m* and *a b n:* Since this Virtue comes in ſtreight



Lines, it's plain that the ſame Quantity of it which falls upon the Line *a b*, will alſo fall upon the Line *c d*; becauſe thoſe Arches are intercepted by the ſame ſtreight Lines *a S* and *b S*: And therefore the Force or Efficacy of this Virtue, acting upon equal Parts of thoſe Lines, by our Authors Demonſtration, will be as the Lines which are the Spaces in which the Virtue is ſuppoſed to be ſpread; but theſe Lines *c d* and *a b* are as the Radij *c S* and *a S*, or their Diſtances from *S*. So that if this Virtue be ſuppoſed to act on Lines or the one Dimenſion of Length only, its Force in different Diſtances is as the Diſtances. Upon the Lines *c d* and *a b* erect Similar Triangles, or other Superficial Figures; they will be to one another in a Duplicate Ratio of their Homologus Sides *c d* and *a b*; but if the Virtue is ſuppoſed to act on theſe Surfaces, there will equal Quantity of it be ſpread in thoſe Similar Superficial Figures, and conſequently upon equal Parts of thoſe Surfaces the Force of that Virtue will be in a Duplicate Ratio of *c d* and *a b*, which are as the Diſtances of thoſe Surfaces from *S*: (as our Author in his Prop. demonſtrates.) Upon thoſe Superficial Figures, erect Similar Cubical Figures, they will be in a Triplicate Ratio of *c d* and *a b*; and conſequently if the Virtue be ſuppoſed to act in a Cubical Space, or upon the three Dimenſions of Length, Breadth and Thickneſs, its Force muſt at different Diſtances be as the Cubes of thoſe Diſtances. *Q. E. D.*

COROLLARY.

Hence it appears that Attraction, which acts upon the whole Subſtance or trine Dimenſion of Bodies, can neither be the Cauſe that turns the Stars in their Orbits, nor the Cauſe that forces heavy Things to fall to the Ground; nor of any Centripetal Force, which in different Di-

Diſtances is as the Squares of thoſe Diſtances.

Mr. *Newton*, in his 10th Prop. aſſerts, that the Planets may keep their Motions exceeding long without Diminution; which he thus proves.

The Air as it riſes from the Earth's Surface rarifies in a great Proportion; ſo that as high as the Planetary Regions it muſt become exceeding thin; and the Reſiſtance of a Fluid being as its Denſity, the Reſiſtance of that Fluid, which in thoſe Regions is ſo exceeding thin, becomes almoſt nothing.

This Proof is extremely weak, for though it be granted that the Denſity of our Atmoſphere decreaſes in any Proportion Mr. *Newton* pleaſes to aſſert; yet neither he, nor any Body elſe that I know of, aſſerts that this Atmoſphere reaches thro' the Planetary Regions, or that the Planets move in our Atmoſphere; but that they have Atmoſpheres of their own, and that thoſe Atmoſpheres are a Part of themſelves, that move along with them; as we are ſenſible that our Atmoſphere moves along with our Earth: But what is the Nature of our Atmoſphere, or the Proportion betwixt the Denſity of its Parts to the Fluid (if any be) that fills the Planetary Regions thro' which our Atmoſphere moves? Nay, is it not taken for granted by Mr. *Newton* and his Followers, from the Refraction of the Rays of Light, when falling on our Atmoſphere; that the Fluid of which it is compoſed is different from that Fluid that fills the Planetary Regions? And if ſo, What does the Denſity, or Proportion of Denſity of the one Fluid relate to the Denſity of the other?

Dr. *Gregory* is ſo ſenſible of the Weakneſs of this Demonſtration, that in this Point he forſakes his Guide, and demonſtrates this Propoſition, after a manner quite different, in his 44th Prop. L. 1. He is alſo ſomewhat more bold in aſſerting; for he affirms the Planets to be in their Motions altogether free of Reſiſtance, and that therefore their Motions may continue undiminiſhed. His Proof of this Aſſertion, is this:

The Orbits of the Planets appear to continue the ſame; but if thoſe Bodies met with any Reſiſtance at all, this Reſiſtance, continuing to act upon them in many Revolutions, could not but produce a ſenſible Effect, * and make their Orbits far different from thoſe Eliptick Orbits, in which they appear to move; theſe being the Figures they are demonſtrated to deſcribe, if no Ways reſiſted.

This Proof is thus far preferable to Mr. *Newton*'s, That it follows fairly enough from what they imagine to be proved before, *viz.* That a Centripetal Force turns thoſe Bodies into Eliptick Orbits; for if the Effect of that Force alone be to turn a Body from a ſtreight Line into an Eliptick Orbit, any other Force alſo acting upon this Body muſt neceſſarily have its full Effect, and in Compoſition with the former, produce a Motion different from what the former alone would do. And its alſo evident that this other Force, if it be at all, is not to be ſuppoſed ſo ſmall as not to produce a ſenſible Effect, when continuing for any conſiderable Time.

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* *Si foret vel minima reſiſtantia* &c. *Planetarum viæ Saltem in Pluribus revolutionibus, immane quantum ab Elipſibus diſcrepare deprehenderentur* &c. *Nulla eſt ergo* &c.

Since this Demonſtration is fairly drawn from what is before, I ſhould not have mentioned it, but that it is a very ſtrong Proof of the Abſurdity of our Authors Hypotheſis: For though it be fair Reaſoning, it gives a much greater Proof of the Abſurdity of that Hypotheſis, than the weak Argument with which Mr. *Newton* ſupports his Hypotheſis in this Point. For to draw an Abſurdity by fair Reaſoning from an Hypotheſis, is to demonſtrate that Hypotheſis to be abſurd; whereas to ſupport an Hypotheſis by weak Arguments, is only to make it probable that the Hypotheſis is falſe.

The Abſurdity that Dr. *Gregory* here demonſtrates from his Hypotheſis is very evident; for if the Planets be abſolutely free of all Reſiſtance in their Motions, then either the Spaces through which they move, are abſolute Voids; or the Bodies with which thoſe Regions are filled, do not react upon the Planets when they force their Paſſage through thoſe Regions. That the Planetary Regions are abſolute Voids, is what I think no Man ever ventured to aſſert, and what I ſhall have Occaſion hereafter to demonſtrate to be abſurd. And I ſuppoſe no Man will deny the Abſurdity of believing that the Bodies (if any be) which fill the Planetary Regions, do not react upon the Planets, when acted upon by the Planets,

nets, and the Planets muſt neceſſarily act upon them to force their Way.

Mr. *Newton* himſelf ſeems to have been well aware of this Difficulty; for he appears not ſo much ſtreightned in any Point as in this, which we may eaſily ſee by the extravagant Accounts he makes up of the Thinneſs of that Ætherial Fluid, which fills the Planetary Regions, drawn from the Hypotheſis of a Diminution of Denſity in the Fluid that lies betwixt the Surface of the Earth and the Planets, continuing in the ſame Chain of Proportion, that begins near the Surface of the Earth in our Atmoſphere; and that the whole Column of this Fluid is equal in Quantity to a Column of Water 33 Foot high: Which two Hypotheſes he repreſents as certain; and from them * calculates that the Denſity of this Fluid, at the Diſtance of one of the Earth's Semidiameters from the Surface is ſo ſmall, that as much Fluid of that Denſity as would fill a Sphere as wide as the Orbit of *Saturn*, would not contain ſo much Matter, as the Quantity of Matter contained in ſo much of our Air upon the Surface as is comprehended within a Spherical Space of an Inch Diameter. And if this be true, this Fluid at the Diſtance of ſo many Semidiameters as the Planets are removed from us, will be ſo thin, that no Reſiſtance that is ſenſible could have been expected from it in a much longer Time than ſince the Creation of the World. And to ſay truth, I think Mr. *Newton*'s Way of acknowledging the Planets to be reſiſted in their Motions, is as reconcileable with their continuing to deſcribe the ſame Orbits without any Diminution of their Motion, as Dr. *Gregory*'s Way of denying that Reſiſtance. And therefore I think the Shift he elſewhere makes was needleſs;

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* *Prop.* 41. *L.* 1.

where he tells us that the Motions of the Planets are really ſomewhat diminiſh'd, as he ſays a late Aſtronomer has found out, by comparing the Calculations of their periodical Times now, with thoſe of the ancient *Babilonian* Aſtronomers. He might as well have ſaid that the Planets (at leaſt the Earth) have ſomewhat increas'd their Motion, from comparing the Calculation of the Aſtronomers in Pope *Gregory*'s Time, with the Calculations of thoſe in *Julius Cæſar*'s Time.

It's ſtrange that the one of our Authors ſhould demonſtrate an Abſurdity from their Hypotheſis, and the other have Recourſe to ſuch ſtrange Shifts, for reconciling it with the Continuance of the ſame Quantity of Motion which is obſerved in the Planets; ſince their Hypotheſis will account for nothing ſo well, as for a Supply of Motion to ballance Reſiſtance and keep up the Stock. Certainly it is not the Fault of that Hypotheſis, that according to it there muſt be a Diminution of the Motion of the Planets; for if our Authors could but account for the Direction in which the Planets move from their Cauſe, and keep them from gathering together in a Cluſter, (which they muſt certainly do, if conſtantly attracting each other) I ſhould help them out of this Difficulty, and ſhow from their Hypotheſis a plentiful Supply of Motion, for keeping up the Stock againſt Reſiſtance.

If we ſuppoſe the Planets to move in Circles, then is the Force of Attraction in the Direction of the Radius, and the Force with which the Body endeavours to run out in the Direction of the Tangent of thoſe Circles. But the Tangent and Radius of a Circle are always at Right Angles; and a Body moved by two Forces meeting at Right Angles, muſt move with a greater Velocity than the Velocity of any of thoſe Forces: So that the one of thoſe Forces, *viz.* the Force with which the Body endeavours to run out in Tangents, being equal in Velocity to the Velocity in which the Body moved the Inſtant before; and leſs than the Velocity in which it is forced by theſe two Forces to move the next Inſtant, *viz.* as the Side of a right-angled Parallelogram to its Diagonal. A Body moved by two ſuch Forces muſt accelerate its Motion every Inſtant or continually; ſo that its Motion in any Inſtant muſt be to its Motion the Inſtant before, as the Diagonal of a right-angled Parallelogram to one of its Sides.

If the Orbits of the Planets be conceived to be Elipſiſes and not Circles, the Increaſe of Motion will be the ſame: For though all the Tangents of an Elipſis are not at Right Angles with the Radij, drawn to one of the Foci, yet there are as many of them at leſs than Right Angles with thoſe Radij, as there are at more than Right Angles; and thoſe that are at leſs, are at juſt as much leſs than Right Angles, as thoſe that are at more, are at more than Right Angles with the Radij, drawn to that Focus. So that whatever leſs Increaſe of Motion there is in one Part of the Elipſis, than there would be if it were a Circle, there is as much greater Increaſe in another Part of that Elipſis: So that if the Sum of the Increaſe of Motion of a Body moving by ſuch Forces, in its performing one full Revolution in an Eliptick and in a Circular Orbit, be compared, they will be found exactly equal.

Here is a plentiful Supply of Motion from our Authors Cauſe, ſo that they need not have Recourſe to ſuch hard Shifts as they make uſe of to palliate this Matter; nay, if this Increaſe be duly conſider'd, I am afraid it will rather be more than our Authors will have Occaſion for, and put them upon as hard Shifts to find Reſiſtance enough for the Planets, as now they are to clear them of Reſiſtance. So that I can hardly tell whether they had not as good be without this Diſcovery; eſpecially conſidering that the Reſiſtance of a Fluid that would then be neceſſary would, according to our Authors themſelves, force the Planets into Spiral Lines; and this would make the Remedy worſe than the Diſeaſe; ſo that they had better be without this Increaſe of Motion, which I have found out for them. But how can they be without it? For nothing is more certain than that the Motion of a Body moving in an Elipſis by one Force in the Direction of all the Tangents of that Elipſis, and another in the Direction of all the Radij, drawn to one of the Foci of that Elipſis, muſt be encreaſed, if ſomething do not deſtroy this Motion, as faſt as theſe Forces meeting in that manner will increaſe it. So that it's abſolutely neceſſary for thoſe, who believe the Planets to move in Eliptick Orbits by a Centripetal Force, to find out ſomething to check this exuberant Motion; and for my part, I can ſee nothing ſo fit for this Uſe as the ſolid Spheres of the Ancients: For thoſe would hinder the Stars from moving in Spiral Lines, and running together; which, as I have already demonſtrated they muſt do, if moved by our Authors Centripetal Force; and in hindring them from running into Spiral Lines, would check the Exuberance of their Motion, and keep them all in good Order. In ſhort, I ſee nothing ſo fit to be joyned with our Authors Hypotheſis, as that of ſolid Spheres; and ſure I am, thoſe Hypotheſes are in ſome Reſpect not unfitly coupled together.

There are ſome very conſiderable Objections that may be made againſt our Author's Account of the Cauſe of the heavenly Motion which he foreſees; one of which he obviates with abundance of Art in his 11th Prop. The Objection is, that if the Sun and Planets mutually attract each other, then muſt the Sun be moved by the Attraction of the Planets,

nets, as well as they by the Attraction of the Sun. But it is agreed upon by all Philoſophers, that the Center of our Syſtem is fix'd, and now no Man of Learning queſtions that the Sun is this Center.

Our Author obviates this Objection, by aſſuming the Hypotheſis, that the Center of the Syſtem of the Univerſe is fix'd, which he knows no Man will deny; and inferring from that Hypotheſis, that the Center of our Syſtem is alſo fix'd. And again, from this Inference proving that the Sun is not the Center of our Syſtem; but an imaginary Point, which he calls the common Center of Gravity of all the Bodies of which our Syſtem is compoſed; and by this Means he takes the Liberty to ſet the Sun (which according to him is not the Center of our Syſtem) in Motion, in his 12th. Prop.

The other Objections of the ſame Nature with this, he does not in this Place meddle with; ſuch as that which forces him to own that the Earth does not perform its Orbit round the Sun, nor ſo much as round that imaginary Point which he will have to be the Center of our Syſtem; but that the Center of Gravity of the Earth and Moon, one imaginary Point, deſcribes an Orbit round the Center of Gravity of our Syſtem, another imaginary Point. Theſe Objections were not quite ſo evident as this he here obviates, and even this he touches very ſlightly; for he tells us not here what ſort of Motion the Sun performs; but only extenuates the Abſurdity as much as poſſible, by producing ſome extravagant Accounts of the Quantity of Matter contained in the Body of the Sun, drawn from his own Principles in his own Method. But what he ſays for fully obviating theſe Objections, he does in his firſt two Books, where he treats of Motions in the Abſtract: For it is not ſo ſhocking to hear that *S* is ſuppoſed to move round ſome other Letter, as to be told in plain Terms that the Sun deſcribes an Orbit round an imaginary Point; nor to hear that *t* deſcribes not its Orbit round *S*, but that another Letter beſides *t* deſcribes this Orbit; as to hear it poſitively affirmed of the Earth, that it deſcribes not an Orbit round the Sun.

All I have to ſay to theſe Things is, that it appears evidently that our Author in this neither proves any Phænomena of Nature to proceed from his Cauſe, nor accounts for any of thoſe Phænomena from his Cauſe; but inſtead of that, makes Phænomena that do not appear, to fit his Cauſe; becauſe it will not fit thoſe Phænomena that do appear, which for that Reaſon he lays aſide. And in my Opinion this Management is ſo far from ſtrengthening his Hypotheſis, that it rather weakens it: For to me it ſeems the livelieſt Proof that can be of the Abſurdity of our Author's Cauſe, when we ſee him obliged to new-model Nature, to make it agree with his Cauſe, becauſe his Cauſe will not agree with Nature.

Our other Author Dr. *Gregory* does not cover ſo well from View this Difficulty, which they are put to in managing their Subject: For he propoſes and accounts for from his Cauſe, all thoſe fictitious Phænomena almoſt without diſguiſe in his 8th and 9th Sections, L. 1. And if any Man do but impartially conſider how that Author is forced to diſtort the Simplicity of Nature, to fit it for his Cauſe, he will ſee the livelieſt Repreſentation imaginable of the hard Neceſſity which Men are put under, (by being obliged to be conſiſtent with themſelves,) when in Phyſicks they advance an Abſurdity; for in Conſequence of one that they have advanced, they are obliged to advance a whole Chain of Abſurdities.

Mr. *Newton*, in his 13th Prop. tell us, that ſince he has diſcovered what Cauſe it is that produces the heavenly Motions, he may now demonſtrate *a priori*, what ſort of Motions the heavenly Bodies perform, *viz.* demonſtrate Mathematically what Motions his Cauſe muſt produce. So that the Phyſical Part of his Subject is now over, and theſe Demonſtrations of the Effects of his Cauſe, are purely Mathematical, and relate no Ways to Phyſicks, if it be true that this Cauſe of the heavenly Motions, which he pretends to have diſcovered, is not the true one, which I think I have made appear: And ſo what follows in our Authors 3d Book does not concern my Subject. And yet I ſhould alſo remark upon theſe Arguments, and ſhow that they are rather worſe than thoſe I have remark'd upon; were it not that to lay open fairly and fully the Fallacies of thoſe Arguments, would oblige me to lay open the other two Books alſo, with which they are connected; and this were to write a great Volume upon a Subject, which to me ſeems not worth ſo much Labour, as the writing

ing It would require; and I believe moſt Readers would hardly think it worth Reading over. So that I ſhall content my ſelf with telling my Reader in general what ſort of Arguments thoſe are, by which he proves from his Cauſe what the Motions of the Planets muſt be.

He knows from the beſt Obſervations, that Aſtronomers have hitherto been able to make, what are the real Motions of the Planets; and thoſe which he thus comes to know to be the real Motions of thoſe Bodies, he (Right or Wrong) demonſtrates that his Cauſe muſt neceſſarily produce.

I ſhall juſtify this Charge againſt our Author, without entering upon a nice Diſcuſſion of his Arguments, by an Inſtance of the moſt conſiderable of the Planetary Motions, about which, not only moſt of his Arguments, but moſt of the Study of all thoſe who contemplate this Subject, are employ'd; I mean the Motion of the Moon.

If that Planet move by the Attraction of the Earth and Sun, and by an Endeavour to run out in ſtreight Lines, it's pain that when ſhe is moving toward her Conjunction, the Attraction of the Sun muſt be in the ſame Direction with the Moon's Endeavour to run out in Tangents, and encreaſe that Part of the Cauſe of her Motion ſtill, till ſhe comes to her Conjunction; and there when this Endeavour is moſt encreaſed, the other Force by which ſhe is attracted to the Earth, and kept from running out in Tangents, is Weakeſt: *viz.* The Attraction of the Earth— the Attraction of the Sun; the Sun's Attraction being juſt of a contrary Direction at that Time to the Attraction of the Earth.

But it's plain that a Body moved by two Forces together, muſt incline moſt to the Direction of that which is moſt powerful, and leaſt to the Direction of that which is leaſt powerful. So that the Moon's Orbit, when in her Conjunctions, muſt partake moſt of the Tangent Direction, or be leaſt incurved toward the Earth, and ſo be moſt diſtant from it.

By the ſame Way of Reaſoning, the Moon, when moving toward her Oppoſition, has her Endeavour of running out in Tangents diminiſh'd by the Attraction of the Sun till ſhe arrive at her Oppoſition, and then is attracted to the Earth by the Attraction of the Earth + the Attraction of the Sun; and ſo by the foregoing Reaſoning, her actual Motion muſt approach neareſt to the Direction of that which is moſt prevalent in its Compoſure, *viz.* the Force by which ſhe is attracted to the Earth; which being increaſed, and the other Force diminiſhed, the Moon muſt then become neareſt to the Earth.

It's very obvious that this muſt be the Figure of the Moon's Orbit, that our Author's Cauſe will produce; and if any Man pleaſe to go more nicely to work, and calculate how much farther the Moon muſt be from the Earth in her Conjunctions than at any other Time, and how much nearer in her Oppoſitions, upon our Author's Principles, he will find the Odds very conſiderable. But for my part, I deſign to meddle with no ſuch Calculations, and think it ſufficient to ſhow in general, that in this moſt conſiderable Part of the Figure of the Moon's Orbit, our Author's Cauſe would demonſtrate a Figure quite different from the real One which appears. And ſince he demonſtrates the real One, it's plain his Demonſtration cannot be ſound; and that Obſervation has directed him in drawing the Concluſion of that Demonſtration, rather than fair reaſoning from his Principles.

This conſiderable Inſtance is ſufficient to juſtify what I aſſerted of the reſt of our Author's Demonſtrations; and may be the eaſier taken for a full Proof of that Aſſertion, ſince that Part of them upon which

I have remark'd, appear to be fallacious; or if any Man is not ſatisfy'd with this, let him examine thoſe Arguments himſelf, and he will find them to be ſuch.

Both our Authors, when ſpeaking of the Comets, ſpeak leſs poſitively of the Nature and Cauſe of the Motions of thoſe Bodies than of the Planets; and what they ſay is no more than to ſuppoſe them to be moved by their Univerſal Cauſe in Parabolas; whereas ſome of the beſt of Aſtronomers, from Obſervation, affirm them to move in ſtreight Lines. But to do our Authors Juſtice, the Sides of thoſe Parabolas, in which they will have them to move, differ very little from ſtreight Lines; and I am inclin'd to believe that the Lines thoſe Bodies do really deſcribe, differ as much from ſtreight Lines as thoſe which our Authors ſuppoſe; though I can ſee no other Reaſon for thinking thoſe Lines to be ſome of the Conick Sections, but that by this Means they are the more manageable and fit for our Authors Purpoſes.

But that which appears ſtrange to me, is that thoſe Comets moving toward the Sun in a Direction ſo near to a ſtreight Line, as our Authors acknowledge, and at the ſame Time attracted by the Sun, do not fall upon it. Certainly the Direction of their Motion, according to all Authors, is not ſo far directed from the Sun, but that ſo ſtrong an Attraction as the Sun, in our Authors Way of reckoning, muſt have at ſo ſmall a Diſtance, would neceſſarily force them into a Direction ſtreight to it; or if it could not force the Comet into a Line directed exactly to the Center of the Sun, yet ſure the Body of the Sun is not ſmall, but extends a great Way beyond that Point on all Sides; and it's ſtrange the Comets do not fall foul of it in ſome Place or other.

Our Authors are ſo full of the Fancy of their having demonſtrated that their Attraction can force a Body into a Curve, that they forget entirely the Natural Effect of Attraction, to make one Body move to another; they think a Body that is attracted can never fail to move in ſome of the Conick Sections, elſe ſurely they would have endeavoured to help their Cauſe in the critical Juncture of a Comet's Perihelium, where it ſtands ſo much in Need of their Aſſiſtance, to keep the Comet from falling foul of the Sun.

There remains yet another of our Author's Demonſtrations, which I muſt not omit to conſider, *viz.* his Demonſtration that the Ebbing and Flowing of the Sea, is produced by the Attraction of the Sun and Moon; which is in his Prop. 24. L. 3.

This Demonſtration conſiſts of a long Narration of the Inequalities of the Tides in different Times, Places, *&c.* ſhowing all along ſome Agreement betwixt the Alterations of the Tides, and the different Poſitions of the Sun and Moon, and eſpecially of the Moon; ſtill ſuppoſing the Tides and their Alterations to proceed from the Attraction of the Luminaries, attracting differently according to their Diſtance, or other Circumſtances. And ſince there is nothing in this Propoſition but Aſſertion, I ſhall in Anſwer to it aſſert, that I believe the Moon to have an Influence upon the Tide, but not the Sun; and that the only Reaſon for thinking the Sun to have ſuch an Influence, as our Author aſſerts, is becauſe the Temperature of the Air has an Influence upon the Ebbing and Flowing of the Sea, and the Sun or the Seaſons of the Year have an Influence upon the Temperature of the Air. That it is this Difference in the Air which immediately affects the Sea, is well known to all who obſerve its Tides, which are as unconſtant as the Weather, and riſe very differently at times, when the Luminaries are the ſame Way placed; neither is this to be accounted for always from high Winds at Sea, driving the Water toward the Shore, or from any ſuch Cauſe.

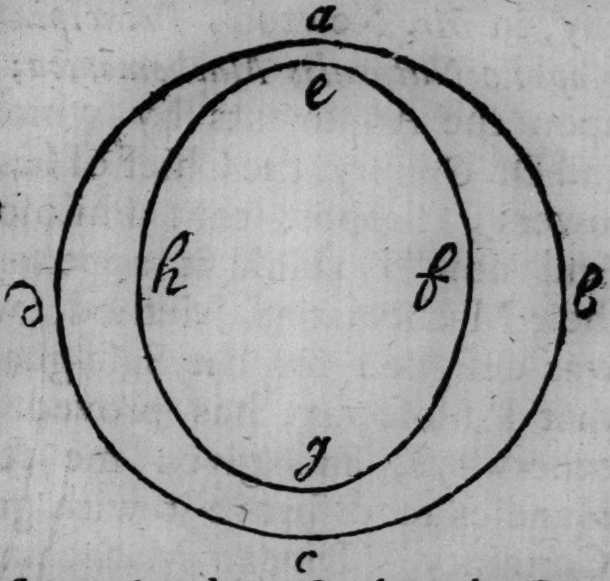
But if it were true that the Tides did ariſe by ſome Influence of both Sun and Moon; What is that to our Author's Cauſe, unleſs he can ſhow that the Attraction of thoſe Luminaries, is that Influence by which this Effect is, or at leaſt may be produced; which he ſuppoſes only and endeavours not to prove? I ſhall however, for full Satisfaction in this Point, ſuppoſe all to be true that our Author aſſerts in this Propoſition, for perſwading People to believe the Ebbing and Flowing of the Sea, to be the Effect of the Attraction of the Sun and Moon, *viz.* that thoſe Attractions can raiſe two Protuberances in the watry Part of our Globe, one under the Moon, and the other upon the oppoſite Side of the Globe, and ſo turn the whole Waters into the Figure of a Spheroid;

roid; and that the Sun and Moon can by their Artractions vary the Shape of this Spheroid, as our Author will have it, by their different Poſitions. And all this being ſuppoſed, I ſhall demonſtrate that the Ebbing and Flowing of the Sea, cannot poſſibly be the Effect of his Cauſe, ſince I ſhall in the following *Theorem* prove, that it muſt be different from what it appears, if produced by that Cauſe.

THEOREM IV.

If the Moon draw the Waters of the Sea by her Attraction, ſo as to make two Protuberances of Water, the one under her, and the other diametrically oppoſite to that, or turn the whole Waters to the Shape of a Spheroid; and if theſe Protuberances be varied by her different Situation, or by the Attraction of any other Body acting upon the Waters alſo; yet Ceteris Paribus, *that Protuberance of the Water which is* *under the Moon, will be conſiderably higher in Reſpect of the Dry-Land, than the Protuberance which is upon the oppoſite Hemiſphere.*

Let the Circle *abcd* repreſent the dry Land, and the Spheroid *efgh* the Waters brought into that Figure by the Moon's Attraction: Suppoſe the Moon to be above the Protuberance of the Waters at *e*. Though *g* be alſo ſuppoſed to be a Protuberance, yet the Waters at *g* are preſs'd to the Earth's Center with the ſtrongeſt Attraction, *viz.* by the Attraction of the Earth + the Attraction of the Moon; whereas the Waters at *e* are preſs'd to the Earth's Center by the leaſt Attraction, *viz.* the Attraction of the Earth— the Attraction of the Moon, and ſo gravitate leſs than the Waters at *g*. The Waters alſo at *f* and *h* are drawn toward *e*, and not toward *g*; beſide the Waters at *g* being moſt preſs'd by Attraction, will run toward thoſe low Places *f* and *h*, whereas the Waters at *e* will not, both becauſe they are leaſt preſſed, and becauſe it is toward *e* that the Waters come from *f* and *h*; ſo that the Protuberance at *e*, or rather the whole Spheroid *efgh*, however otherways it be attracted, yet *Ceteris Paribus*, it muſt come nearer to the Point *a*, in the immoveable Circle *abcd*, than to the Point *c*; ſo that the Tide at *e*, which is under the Moon, (ſince the Moon's Attraction is moſt conſiderable) muſt riſe higher in reſpect of the Land, than the Tide at *g*, which is upon the oppoſite Hemiſphere, contrary to Appearance. *Q. E. D.*



I have now remark'd upon all that can be call'd Natural Philoſophy, in *Mr*. Newton's *Principia Philoſophiæ Naturalis Mathematica*; and upon the Arguments by which he and Dr. *Gregory*, the Chief of his Followers, ſupport that Philoſophy. And now I think it appears that their Mathematical Method, which was deſigned for the Safe-guard of that Philoſophy, has proved quite otherways, and given me ſeveral Handles to diſprove it with greater Certainty, (I mean Mathematical) than I could otherways have done. I think it appears alſo how unfit the Mathematical Method is for proving the dark Points of Natural Philoſophy. Mathematical Demonſtrations, when built upon the ſure Foundation of Mathematical Principles, are like Houſes of great Weight and Solidity, which are built upon a rocky Foundation, and are not eaſily overthrown; whereas he who builds the Superſtructure of a Mathematical Demonſtration upon on the weak Foundation of the Uncertainties in Natural Philoſophy, does the ſame Thing as he who builds a great ſtrong Houſe upon the Sand. And the Arguments by which Mr. *Newton* ſupports his Philoſophy, being of that Nature, could never have ſtood their Ground in the World, for the ſmalleſt Time, had it not been for that almoſt impenetrable Cloud of Obſcurity, with which they were defended from all Attacks.

Mr. *Newton* himſelf tells us almoſt plainly in his Introduction to his 3d Book, that he deſigned thus to defend his Philoſophy from the Attack of Diſputants.* He ſays that his Philoſophy being very inconſiſtent with Mens Ways of thinking, leſt they ſhould call it in Queſtion, he had not propos'd it in the common Method; but put his 3d Book, which contains his Philoſophy, in ſuch a Method, that no Man ſhould be able to underſtand it, without firſt underſtanding the two former Books that were Mathematical; and conſequentlty could not impugn it, till they had firſt diſcuſt thoſe two Books. And the Difficulty there is in underſtanding, and much more in impugning thoſe two Books, with which our Author thus guards his Philoſophy, is very well known to the Learned World. By this Management, Mr. *Newton* put almoſt every Body beyond a Poſſibility of diſputing his Philoſophy; and the World have hitherto received this Philoſophy, as they did of Old the Dictates of their Magi, or the Reſponſes of their Oracles, without knowing the Meaning of what was impoſed upon them, or the Reaſon of what was ſaid to them; which if they had done, thoſe Dictates and Reſponſes were generally ſuch, as they would have deſpiſed. And I am perſwaded had Mr. *Newton*'s Philoſophy been propoſed in ſuch a manner as to have been generally underſtood, it would have had the ſame Fate; and that the Reaſon of its being treated with ſo much Reſpect, was the ſame with that which made the *Heathens* honour ſo much thoſe pitiful Equivocations of their Prieſts.

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* *In libris precedentibus principia Philoſophiæ, tradidi non tamen Philoſophica ſed Mathematica tantum &c. de Mundi Siſtemate compoſueram librum tertium methodo populari, ut a pluribus legeretur, ſed quibus principia poſita ſatis intellecta non fuerint, ii vim conſequentiarum minime percipient, neque prejudicia deponent quibus a multis retro annis inſueverint; & propterea ne res in Diſputationes trahatur ſummam libri illius tranſtuli in propoſitiones more Mathematico, ut ab iis ſolis legantur, qui principia prius evolverint &c.*

Since I have removed thoſe Outworks, by which that Philoſophy has hitherto been rendered inacceſſible, I ſhall make bold with it, and propoſe it barely without any Diſguiſe to the Eyes of the World, who, when they behold it in that manner, will (I am perſwaded) have as ſlender an Opinion of it, as of any of the moſt exploded Schemes of the ancient Philoſophers.

Mr. *Newton* tells us, that * every the leaſt poſſible Particle of Matter, or Body, attracts all Bodies at † all Diſtances; that the Being, whatever it is, that performs Attraction, or puſhes Bodies toward each other, proceeds from thoſe Bodies to which it belongs, and penetrates the whole Subſtance of thoſe Bodies upon which it acts. Dr. *Gregory* tells us, †† that the Virtue, as he calls it, which performs Attraction, is like light Heat, *&c.* ſpread from a Center every Way through the ſurrounding Space equally; ſo that when ſpread through a larger Space, it is leſs in any part of that Space, becauſe more dilated (*Diffuſa & Sparſa* as he expreſſes it,) and when ſpread through a leſſer Space, there is more of it in an equal Part of that Space, becauſe there it is more pent up, (*Conſtipata*) and that the Quantity of this Virtue that is contained in any Part of a greater Space, is to the Quantity of it that is contained in an equal Part of a leſſer Space, as the Spaces.

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* *Prop.* 6, 7 and 8. *L* 3.
† *Page* ult.
†† *Prop.* 48. *L.* 1.

From theſe Accounts, I think, it were unjuſt to ſuppoſe that thoſe Authors deſign to ſay, that Attraction is the immediate Action of thoſe Bodies that are ſaid to attract; for it is not to be thought that they could be guilty of Abſurdities ſo groſs as are included in ſuch an Aſſertion, *viz.* to ſay that Bodies act immediately or by themſelves, without the Intervention of any other Being, in a Place where they are not; that they thus act in many Places at the ſame time; that they proceed from themſelves; that they penetrate each other; that the leaſt Particle of Matter is extended as far as the Limits of the Univerſe, *&c.* It were, I ſay, the higheſt Injuſtice done to our Authors, to ſuppoſe that they mean to aſſert Bodies themſelves tobe the immediateAgents in performing their Attraction, ſince of that which is the immediate Agent, they aſſert what I have mention'd. So that whatever it is that performs Attraction, it muſt be ſomething different from the attracting Body; and, ſince *agere ſupponit eſſe*, it muſt be a real Being.

Let us then conſider what is ſaid of this Being, which is the Inſtrument of Attraction. It proceeds from the ſmalleſt poſſible Particle of Matter equally all around, and extends as far as the Limits (if any be) of the Univerſe; ſo that to every Particle of Matter there belongs a Sphere of this Being as big as the Space or Extent of the Univerſe. The Quantity of this Being that is pent up in any part of thoſe Spheres near their Center, is to the Quantity of it which is in an equal Part near the Surface, in a Duplicate, or rather Triplicate Proportion of the Diſtances of thoſe Places from the Center of the Sphere; and yet ſince this Particle attracts every other Particle in Nature, there muſt not be the leaſt Pore in this Sphere, even near its Surface, where the ſmalleſt Particle of Matter could be free of its Influence; nay, this Being muſt fill even the moſt diſtant Spaces ſo perfectly, as to penetrate the whole Subſtance of thoſe Bodies which occupy any of it, tho' but equally ſpread.

Since every the leaſt Particle of Matter muſt have belonging to it, ſuch a Sphere as I have deſcribed, it's plain, that every one of thoſe Spheres muſt penetrate each other; as well as they do Bodies; and if Matter be diviſible *in infinitum*, there muſt be an infinite Number of ſuch Spheres; or if the Doctrine of Atoms be true, yet the Number of thoſe Spheres will be ſufficiently great.

This extravagant Number of Spheres, of ſo enormous Bulk, and made up of a Being of ſuch a ſtrange Nature, is that by which, according to the *Newtonian* Philoſophers, ſome of the moſt conſiderable Phænomena of Nature are performed. And who would think (when he hears with what Contempt thoſe Philoſophers treat good old *Ariſtotle*, for attributing the Secrets of Nature, which he could not diſcover, to occult Qualities) that thoſe mighty Philoſophers themſelves had recourſe to ſuch an occult Cauſe as this; or who would believe, that they who receive nothing in Philoſophy but what is proved by Experiment and Demonſtration, who reject with Diſdain the Cauſes conjectured by their Predeceſſors, *viz.* Spirits, or Second-rate Divinities, Qualities, Principles, and ſuch like, were themſelves framing Chimera's for producing the ſame Effects, of a much more ſtupendous Nature, than any one of the Fictions of their Predeceſſors? Certainly no Cauſe that ever was aſſigned by any Set of Philoſophers, for the Production of any Effect, was ever ſo ridiculous as thoſe Spheres; and if they had been propoſed to the World in that ſame plain undiſguiſed manner that other Philoſophers have propoſed their Conjectures, they would never have been received; and nothing but the ſhew of Mathematical Demonſtration, together with the Obſcurity with which this Scheme of Phyſicks was veil'd, could have prevented its being hiſs'd off the Stage at its firſt Appearance in the World.

After having conſidered this Philoſophy, as it muſt have appeared to the Imagination at firſt View, if it had been propoſed in the common ſimple Method, in which Natural Philoſophy has always been propoſed; let us next ſee how it muſt have appear'd to the Underſtanding, upon Reflection.

That Reflection upon this Philoſophy which to me ſeems readieſt and moſt natural, is its Repugnance to the Simplicity of Nature, and the Wiſdom of its great Author. For nothing appears more clearly in this Philoſophy, than the vaſt Multitude and confuſed Complication of Cauſes ſuppoſed, for producing a few plain Effects; and nothing appears more clearly in Nature, than the Multiplicity of great and ſtupendous Effects, proceeding from few and plain Cauſes. And it is this very Appearance in Nature, wherein we trace the cleareſt Footſteps, not only of Council and Deſign, but of infinite Wiſdom in the Author of Nature: For to do what one deſigns by the ſhorteſt, ſtreighteſt, and ſimpleſt Means, is the ſure Mark of Wiſdom; whereas to do a great deal more than is needful for bringing about one's Deſigns, is a certain Mark of Folly and Ignorance. And if ſo, how unlike is it to the Simplicity of Nature, and the Wiſdom of its Author, to have ſo great a number of ſuch immenſe Spheres, made up of a Being of ſo extraordinary a Nature, for cauſing Seventeen Spherical Bodies to roll in uniform Orbits, and the Parts of thoſe Bodies to keep together; which is all that theſe Spheres are contrived for by the *Newtonian* Philoſophers? Certainly this is turning Nature upſide down, and placing in it Marks of as great Folly and Ignorance in its Author, as there really are in Nature Marks of his Wiſdom and Diſcretion: For here is a ſtupendous multiplicity of Cauſes made uſe of to produce a few plain and ſimple Effects, inſtead of a multitude of Effects proceeding from a few plain and ſimple Cauſes; which is always obſerved to be the Order of Nature.

The Reflection upon this Philoſophy that ſeems next to preſent it ſelf to our Mind, is the Inconſiſtence of the Nature of that Being, of which thoſe prodigious Spheres (the Inſtruments of Attraction) are made up, according to the Accounts we have of the Nature of that Being from our Authors. * They tell us, that this Being exiſts in a Place ſeparate from that Body to which it belongs, and there acts ſo that it muſt be a Subſtance. † They tell us alſo, that it is dilated in a greater, and compreſs'd and cloſely pent up in a leſſer Space; and that its Quantity in any Parts of thoſe Spaces, is as the Spaces. And from this relation betwixt the Quantity of this Inſtrument of Attraction, and the Quantity of the Space in which it is contained, it appears to be ſomething that is extended; and an extended Subſtance is Body or Matter. So that this Account we have of the Nature of the Inſtrument of Attraction, is equivalent to an Aſſertion that it is compoſed of Body; and from hence a whole Cluſter of Abſurdities follow, *viz.* this Inſtrument of Attraction, which extends to and fills all Places, muſt ſo fill all Space, as to leave no

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* *In immenſas Diſtantias undique extenditur.* *pag.* ult. *Prin.*

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† Prop. 48. l. 1. *Greg. Aſtro.*

Void, or no Space that is not filled with Body, though our Philoſophers themſelves be the greateſt Aſſerters of a Void of all other Sects, ſince their Philoſophy requires the whole Planetary Regions to be almoſt or rather altogether void.

From this it alſo follows, that Body penetrates Body; for we are told that this Inſtrument of Attraction penetrates Bodies: nay, it here follows, that every Body is penetrated by as many different Bodies at once, as there are Particles of Matter in the Univerſe, ſince every Particle of Matter has its Inſtrument of Attraction.

But the greateſt Abſurdity that ariſes from this Reflection is, that every Particle of thoſe Spheres that are the Inſtruments of Attraction, muſt alſo attract; becauſe according to our Philoſophers all Bodies attract; and conſequently every Particle of thoſe Spheres muſt have a whole Sphere belonging to it, to be the Inſtrument of its Attraction; and ſo *in infinitum*.

Though the ſhowing that theſe Abſurdities follow from the *Newtonian* Philoſophy, be as good Proof of its Falſhood, as any that can be drawn from the Principles of Natural Philoſophy; yet I have not ſhowed thoſe Abſurdities, as if I imagined my ſo doing to be a Proof of the Falſhood of that Philoſophy, of ſuperior or ſo much as of equal Evidence and Certainty with thoſe Demonſtrations, by which I havealready Mathematically demonſtrated this Philoſophy to be falſe; or as if I thought that thoſe Demonſtrations ſtood in Need of any additional Proof to ſtrengthen them. My Deſign in giving this ſhort View of the Abſurdities that may be drawn from the *Newtonian* Philoſophy by Phyſical Reaſoning, was only to ſhow the Abſurdities of that Philoſophy, to thoſe who are not ſo well acquainted with Mathematicks, as to gather them from my Mathematical Demonſtrations, where they appear to the greateſt Advantage.

I HAVE now (I think) fully diſproved the *Newtonian* Philoſophy, to the Satisfaction of every judicious Reader; and after all, in ſo doing, I have only ſhow'd that Sect of Philoſophers to be miſtaken in a Matter which has deceived all other Sects of Philoſophers, as well as them; and that their Maſter has not diſcovered the Thing that never Man was able to find out. I have only made appear that they have not hit upon the true Cauſe of the Motions of the heavenly Bodies, and ſo ſet this Philoſophy upon a Level with all others. I ſhall next remark upon ſome Faults peculiar to this Philoſophy, that it may be judged of in Reſpect of other Schemes of Philoſophy, to which this is ſo generally preferred.

It is obſervable of the *Newtonian* Philoſophy, that it is advanced with a greater Shew of Certainty than any other; and that what it propoſes to our Belief, is not propoſed as moſt Parts of Natural Philoſophy ought to be, *viz.* as probable, but as abſolutely certain and mathematically demonſtrated. And ſince this Philoſophy is as falſe as any other, it's plain that it is the more to be found Fault with, by how much the greater Shew of Certainty it carries. For every Body knows that he who advances a Falſhood, the more poſitive he is, and the greater Aſſurance he ſhows in Advancing it, the more he Errs: And that any Man who takes a Proof, which has no manner of Strength in it, for abſolute Demonſtration, is more groſly deceived by that Proof, and is a worſe Judge of Reaſoning, than if he had taken that Proof for probable Reaſoning only. And if this be true, as it certainly is, the *Newtonian* Philoſophers have erred more groſly than any other Sect, and have judged more amiſs of the Reaſons upon which they grounded their Belief.

But let us lay aſide the Manner in which this Philoſophy is propoſed, and conſider the Philoſophy it ſelf.

It contains no more, but that Part of Phyſicks which concerns the Syſtem of the Univerſe; which it's true, is the greateſt, the nobleſt and moſt difficult Part of Natural Philoſophy.

This Part of Philoſophy has been very variouſly and abſurdly handled by Philoſophers; but in theſe latter Ages, the more ridiculous Fictions with which it formerly abounded, were laid aſide; and the Motions of the heavenly Bodies, by the Invention of proper Inſtruments, came to be better diſcovered; and the general Opinion of Philoſophers has been, that the heavenly Bodies moved by the Force of a Fluid, driving them in their Orbits. And when they purſued this Study a little farther, and begun to enquire into the particular Nature of that Fluid, the Manner in which it moved, when impreſſing upon the Stars that Force by which they were kept in their Orbits, and the Cauſe that put it in ſuch a Motion, they went beyond their Depth, and run into many extravagant Opinions, which were inconſiſtent with Nature.

Of thoſe Opinions, the moſt conſiderable was that of *Cartes* and others, who affirmed that the Fluid by which the Planets were forced into Orbits, was made up of a Subſtance of equal Denſity with that Subſtance of which the Planets conſiſted; that the Manner of this Fluid's Motion was in Vortexes; and that the Cauſe by which it was moved in that Manner, was ſome certain Power beſtowed upon the primitive conſtituent Particles of Matter, of turning upon their Axis.

This was the State of Philoſophy, and theſe were the faſhionable Opinions that Men generally entertained of the Cauſes of the heavenly Motions, when the *Newtonian* Philoſophy made its firſt Appearance; and as the Author of that Philoſophy and others very well obſerve, theſe Opinions were preſt with many and great Difficulties. The Planets did not appear to move in the ſame Manner, as thoſe Vortexes by the Laws of their Motions muſt have forced them to do. It appeared alſo incredible that the Matter which compoſed thoſe Vortexes, was of like Denſity with the Bodies of the Planets. And the turning of the primitive Particles of Matter upon their Axis, and ſuch other Motions as were aſcribed to them, look'd very like a Fiction. Theſe were the Sum of the Difficulties by which this Philoſophy was preſt. And it was for theſe Defects that Mr. *Newton* rejected this Philoſopy, and * as himſelf tells us, he propoſes a new Scheme of his own to clear this Part of Natural Philoſophy of the Difficulties that attended the *Carteſian* Hypotheſis.

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* *Hypotheſis vorticum cum Phænominis Aſtronomicis, omnino pugnat & non tam ad explican-*

Let us then ſee how far our Author's Scheme improves that Part of Natural Philoſophy, and clears it of the Difficulties with which the *Carteſian* Scheme was preſt: Suppoſing our Author's Philoſophy had been ſupported by as good Arguments as it appeared to be.

The Sum of the *Newtonian* Philoſophy, as far as it was ſupported by any Arguments, conſiſted in the Diſcovery of the Quantity or Direction of the Force, by which the Planets were kept in their Orbits, abſtracting from that Being whoſe Force this was; and the other Part of

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dos, quam ad perturbandos motus celeſtes conducit; quomodo vero motus iſti in Spatijs liberis abſque vorticibus peraguntur intelligi poteſt ex Libro primo, & in Mundi Syſtemate plenius docebitur, P. 355. *Prin.*

of that Philoſophy, which tells us that the Body, to which this Force is directed, impreſſes that Force upon the Planets, is ſuppoſed only, and not the leaſt Shew of Argument offer'd to prove it, as I have ſhewed before. So that no Man could think better of this Philoſophy, than that the Abſtract Quantity of Force, by which the Planets were actuated, was Matter of Demonſtration and Certainty; and that the Aſſertion or Suppoſition, that this Force proceeded from the Action of that Body to which the Force was directed, was Matter of Opinion or Hypotheſis only; no Man could think any better of this Philoſophy, except they took its Author's bare Word for Proof.

It is hardly to be ſuppoſed that Men of Learning or good Senſe could ever have had ſo good an Opinion as this of the *Newtonian* Philoſophy, or have thought that the Quantity or Direction of the Force by which the Planets were actuated, could be matter of Demonſtration: For they who knew any thing of reſolving Motions, could not but know this in general, that any given Motion whatever may be reſolved into an infinite Number of different Forces; and that therefore it might be Mathematically demonſtrated, that no Demonſtration could ever be brought to prove, of any Motion whatever, that it muſt neceſſarily be produced by any certain Force. And even thoſe who did not underſtand any thing of reſolving Motions, could not but know that the Current of a River (for inſtance) might deſcribe an Arch of ſome Circle; and if a Log of Wood were thrown into this Current, it would force the Wood to deſcribe round the Center of that Circle Areas proportionable to the Times: and yet it is plain, that the Current preſſes not upon that Log of Wood with a Force directed toward the Center of that Circle. And from this Similitude might gather, that a Force directed to a Center, could never be the only Force that could make the Planets deſcribe round that Center Areas proportionable to the Times.

It may indeed be ſuppoſed that Men of Learning and good Senſe were ſo far deceived by our Author's Arguments, as to believe that a Centripetal Force might produce the Motions of the Planets, or that theſe Motions might be accounted for from a Force of that Direction; but it cannot never be thought that any, who conſidered the Matter, could think that no other Force but that could produce this Effect: Nay, I am convinced that it is true in Fact, that the learned World generally underſtood no more to be proved by our Author's Arguments, but the fitneſs of this Force for producing the Effect; and never queſtioned but a Force of that Direction and Quantity, (whatever this Direction and Quantity was) which a Fluid equidenſe with the Bodies of the Planets moving in a Vortex of the

Shape of their Orbits could impreſs upon them, was a Force at leaſt as fit for carrying them in their Orbits, as a Centripetal Force could be. So that if the abſtract Quantity of Force had been all the matter in Queſtion, the *Newtonian* Philoſophy could have pretended to be no more than equal with the *Carteſian.*

The *Carteſian* Philoſophy, or the Hypotheſis of Vortexes, (ſays our Author) is preſs'd by many Difficulties: But what Difficulties? Sure it was never by any Man objected againſt this Philoſophy, that the Abſtract Quantity of Force ſuppoſed, was not ſufficient for producing the Motion that appears, *viz.* That the Current of a Fluid equidenſe with the Planets, could not carry them along with it, or impreſs ſuch a Force upon them, as was ſufficient to make them deſcribe ſuch Figures as the Figure of the Vortex. The Difficulties with which this Hypotheſis was preſs'd, only aroſe from what *Cartes* ſaid of the Nature of that Fluid which compoſed theſe Vortexes, and the Cauſe and Manner of its being brought and kept in that vortical Motion. If *Cartes* had ſaid no more in Philoſophy, than barely to have condeſcended upon the abſtract Quantity of the Force of his Vortexes, as our Authors do, he would have been clear of all ſuch Objections. And what is it that defends the *Newtonian* Philoſophy from Objections of the ſame nature, but that they advance leſs, and do not tell us what is the Nature of that Being which impreſſes upon the Planets their Centripetal Force; and what is the Cauſe that makes it act upon them, nor in what manner it acts. So that their Philoſophy is only preferable in advancing little: and if this be a Perfection, he that meddles not at all with Philoſophy, is the beſt Philoſopher.

But after all the Caution the *Newtonian* Philoſophers uſe in this matter, they ſay as much of that which, according to them, is the thing that impreſſes upon the Planets their Centripetal Force, as ſhows their Hypotheſis to be in that reſpect preſs'd with much greater Difficulties than any that were ever urged by any Man againſt the *Carteſian* Philoſophy; as ſufficiently appears from the ſlight View I have given of the Abſurdities that may be drawn from their Hypotheſis by phyſical Reaſoning; which all follow from the Nature of that Being, which, according to our Philoſophers, impreſſes upon Bodies their Centripetal Force, and the manner of its performing that Operation; the very ſame Sources from whence thoſe Difficulties, by which the *Carteſian* Philoſophy is preſs'd, does ariſe.

It appears then that the *Newtonian* Scheme did in no reſpect amend the Faults of the *Carteſian* Philoſophy; but in all thoſe very ſame Circumſtances, in which the *Carteſian* Philoſophy failed, was much more de-

defective than it, even if the *Newtonian* Philoſophy had been as good as it can be ſuppoſed to have appeared to any Man of Learning or good Senſe. But let us ſuppoſe the World to have been intirely deluded with the Arguments by which that Philoſophy was ſupported, and to have thought every thing that was in the leaſt like the Shape of a Demonſtration to have been really ſuch, and that thoſe Demonſtrations concluded what the Propoſitions aſſerted in the ſtricteſt Senſe of the Words; ſtill all they could have believed from thoſe Demonſtrations was, that no other Force but a Centripetal could poſſibly produce the Motions of the Planets: But ſtill they had no reaſon to believe it to be certain, that this Centripetal Force was impreſs'd upon the Planets by the Action of that Body which was placed in that Center. For this is what no Propoſition aſſerts, and for which nothing like Proof of any kind is offered. And it appears evidently to any Man that will but read over this Philoſophy, that this is only ſuppoſed; and if this be no more than Hypotheſis, why not inquire into the Difficulties by which ſuch an Hypotheſis is preſs'd? Which if any Man had done, could any thing be more obvious than thoſe Difficulties? Such as the Difficulty of ſuppoſing a Body to act immediately in a Place where it did not ſo much as exiſt; or if that was not ſuppoſed to be the immediate Action of that Body, then was it as difficult to find a proper Inſtrument for conveying ſuch an Action.

All the Advantage that could ariſe to the *Newtonian* Philoſophy, from taking for certain all that was ſupported by any thing like Demonſtration, was only that then indeed the Hypotheſis of Vortexes muſt be laid aſide, ſince nothing but a Centripetal Force would do the Buſineſs. But why might not this Centripetal Force ſtill have proceeded from the

Action of a Fluid? The probabilities of a Fluid being the Mover of the Planets, which forced ſo many Philoſophers into that Opinion, ſtill remained in full Force: and it was but changing the Hypotheſis, and inſtead of ſuppoſing the Fluid, by which the Planets were moved, to run round in a Vortex, it might have been ſuppoſed to run to a Center. It's true indeed, the Theorem by which it was demonſtrated, that nothing but a Centripetal Force could cauſe the Planets to deſcribe ſuch Orbits as they do, would in that caſe have been a very conſiderable Improvement to that part of Natural Philoſophy. But ſtill the Author of this Theorem could not be ſuppoſed, by his Invention, to have acquired a right of employing any thing he pleaſed to put in execution that Centripetal Force which he had diſcovered to be neceſſary. So that he ought not in ſuch an arbitrary manner to have affirmed, that his Centripetal Force was produced by the Action of that Body to which it was directed. His Diſcovery, at beſt, was but a Diſcovery of the abſtract Quantity of Force, by which the Planets were moved; and not of the Mover, whoſe Force this was. And he ought not to have affirmed any thing to be this Mover, without having ſome other ground for ſo doing, than his having diſcover'd the Quantity of Force impreſs'd upon the Planets. But if he had aſſerted no more than what he ſeem'd to have diſcovered, his Invention would only have appeared to be an Improvement of other Mens Opinions; whereas by managing the Matter as he did, he made much more of his Diſcovery, and paſs'd it upon the World for a whole Scheme of the Syſtem of the Univerſe, perfectly new, and modelled by a Cauſe which he only had found out, and which was utterly unknown to former Ages.

It was a very ſingular Piece of Management in our Author, to make ſo much of ſo little, or rather of nothing at all; and to get the World ſo generally to believe an arbitrary Aſſertion, ſupported by no Proof, nay, not ſo much as by the ſhew of any Argument; for no Reaſon, but becauſe he had diſcover'd, or rather ſeemed only to diſcover, ſomething quite different from that Aſſertion; eſpecially, ſince as I have already made appear, this Aſſertion is preſs'd by as great and as obvious Abſurdities and Inconſiſtencies, as it is poſſible for any thing that is aſſerted in Natural Philoſophy to be.

I have hitherto compared this Philoſophy, and its Method, with other Schemes of Phyſicks and their Methods, and particularly, with that which was by the World generally received at the time when this Philoſophy was firſt propos'd, and was generally rejected after its Appearance; and have made appear, that in every reſpect in which that Scheme of Phyſicks was preſs'd with Difficulties, our Scheme was preſs'd with much greater ones of the ſame kind: And that tho' our Scheme had been as good as it can be ſuppoſed to have appeared to any Man of Learning or good Senſe, yet it could appear in nothing perferable to that Scheme which was thtown off to make way for it. All which makes the Management by which this Scheme was recommended to the World, appear to be very extraordinary.

I ſhall now enquire into the Reaſonableneſs of a Poſtulate, upon which that Philoſophy depends, *viz.* that the Planets are free of Reſiſtance.

I call this a Poſtulate, tho' both Mr. *Newton* and Dr. *Gregory* pretend to prove it, becauſe the Demonſtration of the former of thoſe Authors depends upon a Poſtulate equivalent to it, *viz.* that the Fluid, which lies betwixt us and the Planets, rarifies in the ſame continued Chain of Proportion that begins in the lower parts of our Atmoſphere; by which he computes, as I ſaid before, that the Denſity of that Fluid, at the Diſtance of one of the Earth's Semidiameters from the Surface, is to the Denſity of it upon the Surface, as a Globe whoſe Diameter is equal to the Diameter of *Saturn*'s Orbit is to a Globe of an Inch Diameter; and ſo this Fluid continues to rarify in that Proportion, till it come to the planetary Regions. This Poſtulate, upon which Mr. *Newton*'s Demonſtration of the Abſence of Reſiſtance depends, is certainly equivalent to his poſtulating what he proves; nay, much more ridiculous.

Dr. *Gregory*'s Proof of the Abſence of Reſiſtance, is no more than a Proof that their Scheme cannot ſubſiſt without it: And that Author tells us in plain Terms *, that this Abſence of Reſiſtance is all along ſuppoſed in thoſe Propoſitions where their Centripetal Force is reconciled with the Phænomena of the heavenly Motions; nay, the making appear that this is ſuppoſed, and that without that Suppoſition their Cauſe would not be reconciled with its pretended Effects, is all the Demonſtration he brings to prove this Abſence of Reſiſtance.

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* *In Propoſitione ubi determinatur lex vis Centripetæ qua urgetur Corpus quod revolvitur in perimetro Elipſis aut alterius Sectionis Coni, cujus fcœorum*

But that which makes it moſt clearly appear that this is a Poſtulate, is, its being ſuppoſed in Mr. *Newton*'s firſt Propoſition, *L*. 1. and Dr. *Gregory*'s Eleventh Propoſition, *L*. 1. upon which their whole Syſtem depends. For in thoſe Propoſitions it is aſſerted of the moving Body, that if it move a certain Space in a certain Time, it will by the Nature of Bodies in Motion move a Space equal

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focorum alter eſt Centrum ad quod vis tendit; ſuppoſuimus motum utrumq; ex quibus Componitur motus in Curva Elliptica Parabolica vel Hyperbolica, omnino liberum nec illi quidquam obſtare aut reſiſtere, &c. L. 1. Prop. 44.

qual to that Space in equal Time, if nothing hinder it; and upon this theſe Propoſitions depend, as will appear by looking to thoſe Propoſitions themſelves, or to thoſe Propoſitions as I have repeated them in the Beginning of my Remarks. So that all our Scheme is evidently built upon this Poſtulate, that nothing reſiſts the Planets in their Motions. But if any Body were in thoſe Regions through which the Planets move, they muſt force this Body out of their Way, and it muſt return that Force by its Reaction, and this Reaction is Reſiſtance; ſo that if the Planets are not reſiſted, there muſt either be no Body at all in the Planetary Regions, and ſo they are abſolute Voids, or at leaſt ther muſt be no more Body there than Mr. *Newton*'s Computation of the Denſity of the Fluid he allows to be there, will admit; which is much the ſame Thing as no Body at all.

I admire that our Authors ſhould have poſtulated of the World to believe that not to be, which not only all Philoſophers, but (I may rather ſay) all Mankind believed to be. Certainly no Man ever believed the Planetary Regions to be Voids, nor will either Senſe or Reaſon allow any Man to believe it. But ſtill if this Poſtulate had been leſs improbable, and it had been no more than the general Opinion of Mankind, that the Planetary Regions were not void; the Reſpect due to ſuch an univerſal Sentiment in which Men agreed, required ſome Reaſons to be given to the contrary; and it was an extraordinary Piece of Aſſurance, thus to poſtulate of the World, that they would renounce ſo general an Opinion: As much as if it had been ſaid in plain Language, Gentlemen, renounce that Opinion you have always had, and believe the contrary, without any Reaſon for ſo doing.

This is certainly the moſt extravagant Poſtulate that ever was heard of; nay, it is not only ſo with reſpect to the univerſal Belief of the contrary, but alſo with reſpect to the Evidence and Certainty with which the contrary appears, and may be demonſtrated to be true: For what Point in Natural Philoſophy appears with more Evidence, than that the Planetary Regions are not Voids? What Proof does Natural Philoſophy afford that is more ſtrong, or rather what Proof will the Nature of the Subject admit of, that is more evident than the Proof that the Planetary Regions are filled with ſome ſort of Body?

That ſort which moſt certainly appears to fill the Planetary Regions is Light, which I ſhall not here take up Time in proving to be a Body, becauſe that is owned by our Philoſophers; neither ſhall I endeavour to prove any thing particular of the Nature of that Body, or endeavour to ſhew it to be ſomething different from what the *Newtonian* Philoſophers believe it to be, tho' I think it ſo, becauſe that relates not to the Point in Hand: For whether it be ſuch a Body as I take it to be, or ſuch as thoſe Philoſophers believe it to be, is all one, as far as concerns the Point in Queſtion. So that I ſhall ſuppoſe it to be juſt ſuch a Fluid as they do, ſent from the Body of the Sun in ſtreight Lines, through all the Planetary Regions ſucceſſively every Inſtant of Time, or by a continu'd Emiſſion of that Fluid from the Body of the Sun.

If then Light be ſuch a Body, is not the Planetary Regions filled with this Body according to our Philoſophers themſelves? And how can they for ſerving a Turn, at another Time aſſert, that the Planetary Regions are Voids? Or at leaſt, what is equivalent to this Aſſertion, that the Planets move thro' theſe Regions free from the Action or Reaction of any thing, but Attraction only?

If to put aſide this Difficulty, they diminiſh extravagantly the Quantity of Matter contained in the Fluid of Light; as Mr. *Newton* does the Quantity of that other Fluid, which he acknowledges to lie betwixt our Earth and the Planets; and after ſuppoſing the Quantity of this Fluid to be ſuch as will ſuit their Occaſions, then tell us that the Force of the Action of a Fluid being as its Quantity, the Force of the Action of this Fluid is almoſt nothing; it will not be very eaſy to bring full Proof to the contrary. And this Shift is to be expected from our Philoſophers, ſince they have ſuch a ſingular Art in framing Hypotheſes to fit their Purpoſe, and take Liberty to ſuppoſe what they pleaſe, and to turn out of the Syſtem of Nature any thing that is repugnant to their Scheme, though appearing with the fulleſt Evidence imaginable. But if they take that Method in this Caſe, and aſſume ſuch an unreaſonable Hy-

Hypotheſis without any Probability, merely becauſe the Inconſiſtence of their Scheme with Nature forces them to do ſo, this will be a Proof of the Falſity of both their Scheme and Hypotheſis; than which it is hard to find better Proof in Natural Philoſophy. For they who indulge themſelves a full Liberty of framing as many Arbitrary Hypotheſes as they have Occaſion for, may ſtand out againſt all the Arguments that can be brought againſt them; for if in any thing they be ſtreighten'd, it's but ſuppoſing ſomething to be ſuch as will ſerve to anſwer the Difficulty, and their Streight is over. And they who can play this Game with a little Art, are Proof againſt all the Demonſtrations that can be brought, and cannot be convicted of their Errors ſo as to be forced to own them to be ſuch.

If our Philoſophers had managed all along this Way, I ſhould have had much harder Work with them than I have had; and ſhould never have been able by full and poſitive Demonſtration to diſprove their Philoſophy: For this I have only been able to do, becauſe their Philoſophy conſiſts chiefly in Aſſertions of Abſtract Quantities, which brings it within the reach of Mathematical Demonſtration; whereas this which is a Point of a quite different Nature, is not to be diſproved with equal Evidence.

I ſhall however ſhow, with as great Evidence as the Nature of the Subject will allow, and conſequently as great as is to be expected, that the Quantity of Matter contained in the Fluid of Light is not ſo ſmall, as that the Action of that Fluid upon the Planets ſhould for that reaſon be thought inſenſible; or rather, that in Fact this Fluid acts upon them with a Force that cannot but have ſome ſenſible Effect upon their Motions. For making of this appear,

Let us ſuppoſe the Planets to be covered with Atmoſpheres, or if that be not allowed, let us take for inſtance

ſtance our Earth, which we know to be ſo. Theſe Atmoſpheres are parts of the Planets, ſince they turn with them upon their Axis, and accompany them in their Motions; in ſhort, thoſe Atmoſpheres are joined to the Planets by the ſame Cement of Gravity (whatever the Cauſe of Gravity be) which keeps together all their other Parts. This appears very clearly to be true in the caſe of our Earth. And if thoſe Atmoſpheres be thus join'd to the Bodies of the Planets, it's plain that any Force impreſs'd upon theſe Atmoſpheres muſt in effect be alſo impreſs'd upon the other Part with which they are connected.

It is very eaſy to judge of the Effect that any Force acting upon our Atmoſphere muſt have upon the Globe, from the Effect it appears to have upon the Atmoſphere, and from the Force that our Atmoſphere can impreſs upon ſolid Bodies; which appears in the Impreſſion that Winds (which are nothing elſe but

Currents in our Atmoſphere) make upon Bodies; or by computing the Denſity of our Atmoſphere and Globe, and proportioning the Effect of any Force upon theſe two to their Denſities. And ſince the Force of Wind even upon Bodies of great Denſity, appears to be conſiderable, and that the Difference of the Denſity of our Globe and Atmoſphere is not extreamly great; it's plain, that a Force which produces upon our Atmoſphere any great Effect, muſt produce alſo upon our Globe much more than is conſiſtent with that abſolute Freedom in the Motions of the Planets, for which our Philoſophers contend. So that the thing which comes now to be conſider'd is, what Effect the Fluid of Light, the Sun-beams, or whatever elſe That may be called, which the Sun ſcatters continually through the whole planetary Regions, produces upon the Atmoſpheres of the Planets, or upon our Atmoſphere in particular.

This Force is diſcoverable in that

Phænomonon which we call Rarefaction, or Tenſion of Air, which is effected by the Action of the Sun-beams, and cannot be performed without a Force driving the Air from that place which it naturally affects. The Force by which the Sun-beams thus drive the Fluid of our Atmoſphere, may be eſtimated from the Tenſion of Air it produces, and from the Force that is neceſſary to make ſuch Tenſion; which appears from the Inſtruments by which an artificial Tenſion of Air is produced.

The Tenſion of Air that ariſes from the Heat of the Sun, appears very clearly to be produced by a Force, whereby the Sun-beams drive the Air before them in the *Eaſt* Winds, within the Tropicks; and the Effect of this Force, when communicated by our Atmoſphere to the Solid, at leaſt the Watry part of our Globe, which is almoſt Equidenſe with the Solid part, appears alſo very plainly in the conſtant and general Motion of the Sea, in the ſame Direction with thoſe Winds. And they who have any Taſte of Natural Philoſophy, will, in this Appearance, evidently ſee that the Sun-beams, with which the planetary Regions are filled, impreſs upon the Planets continually a very conſiderable Force; ſo that thoſe Planets do not, as our Authors ſuppoſe, paſs through theſe Spaces, abſolutely free of any Force acting upon them.

But becauſe every Reader cannot diſcover in this Phænomenon, which I have inſtanced, the Proof of what I aſſert, becauſe they are not accuſtomed to thoſe ways of Thinking that are neceſſary for their perceiving the full Evidence that may be ſeen in that Appearance; I ſhall inſtance another Phænomenon, in which it appears evidently even to the Senſes, that the Sun-beams act with a conſiderable Force upon the Bodies that move through the planetary Regions.

Aſtronomers agree, that all Comets turn their Tails always directly away from the Sun, whether moving to the Sun or from it, or whatever way their Situation in reſpect of it changes; and if ſo, they who have ſeen a Comet, have ſeen it acted upon by the Sun-beams, and they who never ſaw a Comet, have the univerſal Teſtimony of thoſe who have ſeen it.

It is very eaſy to ſhow, that the Force with which the Sun-beams act upon a Comet, is evident in this Appearance, by what our Philoſophers themſelves acknowledge. Sir *Iſaac Newton* ſays *, that the Tails of the Comets are made up of the Exhalations drawn from the Body of the Star by the Heat of the Sun; and that theſe Exhalations near the Body of the Star, appear like Smoke ariſing from it; and when ariſing in great plenty, make the Body of the Star ſeem much more obſcure, and appear with a fainter Light than otherwiſe therways it would do. And if this be true, as it certainly is, that the Tail of a Comet is made up of the Smoke and Exhalations, which the Heat of the Sun draws from the Body of the Star, the Matter of which theſe Tails are compoſed before it was by the Heat of the Sun ſeparated from the Body of the Star moved in the ſame Velocity and Direction as the Star, and muſt have continued ſo to do, if ~~moving~~ in a place were nothing acted upon or reſiſted it; and the Smoke and Flame ariſing from the Comets muſt be hindred from keeping cloſe to the Comet, which by the Law of Motion they muſt have done by ſome Force, either by that Force which cauſes the Smoke and Flame proceeding from ſolid Bodies upon our Earth, to tend upwards, or move ſtill directly away from the Earth, *viz.* the greater Gravity of our Atmoſphere; and then this Appearance will prove that Fluid in which the Comets ſwim, to be heavier or more denſe than the Exhalations drawn from the Comet by the Heat of the Sun; or elſe thoſe Tails muſt be drove that way by the Force of the Sun-beams.

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* *Prop.* 41. *L.* 3. Prin.

I believe our Philoſophers will not readily allow, that the Cauſe which forces the Tails of the Comets to point from the Sun, is the ſuperior Denſity of that Fluid in which thoſe Comets ſwim; becauſe this were to allow that Fluid to be of equal Denſity with our Atmoſphere, which it muſt be if that be the Cauſe; ſince we cannot ſuppoſe the Smoke and Exhalations drawn from the Bodies of the Comets, to be of a Nature far different from the Smoke and Exhalations drawn from other Bodies, which does not riſe in a Fluid leſs denſe than our Atmoſphere. This, I ſay, our Philoſophers will not allow, becauſe allowing the planetary Regions to be filled with a Fluid as denſe as our Atmoſphere, were giving up their Cauſe. And if they ſay, that the

Tails of the Comets are drove by the Sun-beams, they own what I am proving.

For my part, I cannot ſee any other Cauſe from whence the Force by which the Exhalations drawn from the Bodies of the Comets are drove from the Sun can proceed, but thoſe two which I have inſtanced. But it matters not much, whether our Philoſophers allow any of thoſe to be the Cauſe or not, ſince whatever Cauſe be aſſigned for the Production of this Appearance, yet ſtill the Appearance it ſelf ſhows that it is ſomething in the planetary Regions that impreſſes upon Bodies moving through thoſe Regions; ſuch a Force as can upon Smoke produce a very powerful Effect: And this Force, whatever it is that has ſuch an Effect upon the Smoke that ariſes from the Comets, cannot but have ſuch an Effect alſo upon the Atmoſpheres of the Planets, ſince they are made up of a Subſtance very near of the ſame Denſity; nay, whether the Tails of the Comets be allowed to conſiſt of ſuch Exhalations or not, yet they appear to be parts of the Comets which are joined to them, and move along with them. And without entring into any nice Enquiry into the Nature of thoſe Tails, even they who know nothing of Natural Philoſophy, cannot but ſee from a Comet's turning its Tail always from the Sun, that the Fluid in which it is, impreſſes upon it a ſenſible Force; as well as by ſeeing a Ship that lies at Anchor turn always her Stem to the Tide, or a Weather-Cock ſtill turn his Head to the Wind, they may believe that the Current of Water beats upon the one, and the Wind upon the other. In ſhort, a Man might as well ſee a Ship at Sea, with full Sails, bending from that Side upon which the Wind did beat, and as the Wind ſhifted or the Ship changed its Courſe, ſtill leaning directly away from the Wind, and believe that the Wind impreſs'd upon on the Sails of that Ship no Force, or that thoſe Sails communicated to the Hull no Force able to produce upon it any ſenſible Effect; as ſee a Comet turning its Tail ſtill away from the Current of Light proceeding from the Sun, and believe the Sun-beams to impreſs upon that Tail no Force, or that the Tail communicated to the Body of the Star no Force that is ſenſible.' The Atmoſpheres of the Planets, like the Sails of a Ship, are extended wider through the Regions in which the Planets move, than the Body of the Planet, and ſo are more obnoxious to the Impulſe of that Etherial Fluid, and muſt neceſſarily communicate to the Body of the Planet what Impulſe they receive, either from the Sun-beams, or any other Fluid whatever that is in the planetary Regions. And tho' I might bring very good Arguments for proving other Fluids beſide that of Light to be in theſe Regions; yet what I have proved of that only, ly is ſufficient; and he who will not by what I have already ſaid be convinc'd that the Stars move not through the Planetary Regions at abſolute Freedom, will never be convinc'd of any thing by Phyſical Reaſoning.

I think it now appears how unreaſonable it was for the *Newtonian* Philoſophers to build their Philoſophy upon an Hypotheſis, that the Planets move through the Planetary Regions at abſolute Freedom: Since that Hypotheſis was not only inconſiſtent with the Opinions of all Philoſophers, but in it ſelf abſurd and inconſiſtent with the Phænomena of Nature. So that not only the Method of the *Newtonian* Philoſophy, and the Philoſophy it ſelf, but the Hypotheſis upon which it is built, is worſe than moſt Hypotheſes upon which other Schemes depend, eſpecially that to which ours ſucceeded.

I have hitherto purſued my Subject, ſo as to ſet it in the beſt

Light I could, without conſidering whether what I happened to ſay might give Offenſe to any Perſon whatever. And upon Reflection, I find that the Proſecution of my Subject, and the Endeavour of ſetting it in the beſt Light, has drawn me to repreſent the famous Sir *Iſaac Newton* as One that has not made ſo great Improvements in Philoſophy as he is generally believ'd to have done; and conſequently, ſome Readers may think, that I derogate from the Honour of that Great Man. For my part, I am quite of another Mind, and believe nothing to be true Honour, but what is built upon a ſolid Foundation, as *Cicero* deſcribes it, *Conſtans Laus bonorum*; and conſequently, that the Honour due to this great Man for his real Improvements of Learning, will remain unſhaken to After-Ages, and is above the Reach of the Tongue or Pen of the Envious; and I ſhould deteſt my ſelf, if I could think that I were capable of the impotent Endeavour of detracting from his deſerved Praiſe. But if Sir *Iſaac Newton* has in any thing been miſtaken, and the World has been too fond of any of his Miſtakes, and not diſtinguiſh'd thoſe from his ſolid Inventions; it derogates neither from the real Worth of that great Man, nor from his ſolid and laſting Reputation, but rather ſettles it on that Foundation upon which it muſt continue, to undeceive the World in theſe Matters: And beſide this, Truth and the Improvement of Learning, Cauſes of ſo general Concern as not to be over-ballanced by private Conſiderations, require this to be done, and therefore the doing of it needs no Apology.

FINIS.

MVSEVM BRITANNICVM

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